

WATERBULLETIN

Nuusbrief van die Waternavorsingskommissie
Newsletter of the Water Research Commission

NOVEMBER 1982

Geohidrologiese navorsing: WNK finansier nuwe projek

Die Waternavorsingskommissie het 'n kontrak met die Universiteit van Stellenbosch en die Departement van Omgewingsake aangegaan ter bevordering van geohidrologiese navorsing in Suid-Afrika.

Die navorsingswerk wat in die opvanggebied van die Poesjenelsrivier, 'n sytak van die Breërvier in Wes-Kaapland, sal plaasvind, behels gedetailleerde geohidrologiese ondersoeke met spesiale verwysing na mineralisasie. Die nuwe projek sal na verwagting vier en 'n half jaar duur en staan onder leiding van mnr G J Greeff van die Departement Geologie aan die Universiteit van Stellenbosch.

Kommer oor die mineralisasie van verskeie Suid-Afrikaanse riviere het reeds in die laat sestigerjare aanleiding gegee tot 'n reeks

navorsingsprogramme waaraan die WNNR en verskeie staatsdepartemente en universiteite deelgeneem het. Die navorsingsprogramme is

gekoördineer deur 'n staande komitee wat bekend gestaan het as die Werkgroep vir Mineralisasie en
(Na bladsy 8)

SOUT IN WES- KAAPSE RIVIER BESTUDEER

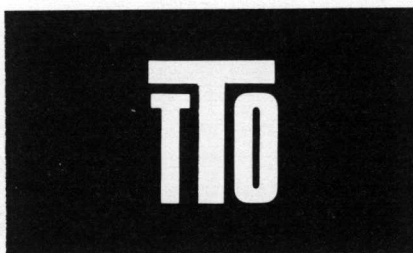


Die Poesjenelsrivier in die Wes-Kaap waar navorsing deur die WNK gefinansier word.

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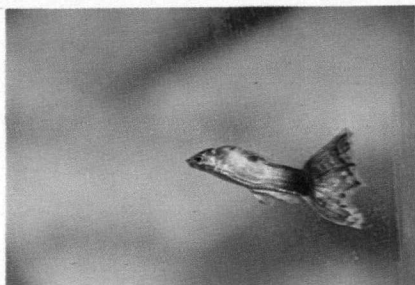
TEGNOLOGIEOORDRAG

In hierdie rubriek sal gereelde aankondigings verskyn van publikasies, simposia of ander gebeurlikhede met 'n praktiese inslag wat kan help om die gaping tussen navorsing en toepassing te oorbrug.



TECHNOLOGY TRANSFER

In this column regular announcements will be published of publications, symposia and other events of practical import which could contribute towards closing the gap between research and application.



The guppy.

Over the past few years one biomonitoring system has shown a great potential for the detection of industrial and other pollutants in the water environment. Developed at the National Institute for Water Research (NIWR), in collaboration with the National Electrical Engineering Research Institute (NEERI) of the CSIR, the technology has already found application in a paper mill, a chemical factory, and in water reclamation plants. This article takes a closer look at the promising

Fish biomonitoring system

In dié uitgawe In this issue

- **St Helena: Fisheries effluent – pilot plant demonstration** 5
- **Fosfaatverwydering: 'n lekebenadering ..** 11
- **Nuwe kursus in water-versorging by Technikon** 17
- **Water stress and evaporation studies** 18
- **Rhodes report on Buffalo River catchment** 28

8-page Section on



EQUIPMENT starting on page 36.

Increasing public concern about pollution of the water environment has caused industry to take a careful look at the effect of its effluents on biological systems.

Monitoring of industrial wastewaters currently depends mainly on physical-chemical measurements which cannot infallibly detect harmful effluent discharges in good time, owing to intervals inherent in sampling procedures.

Conventional physical-chemical

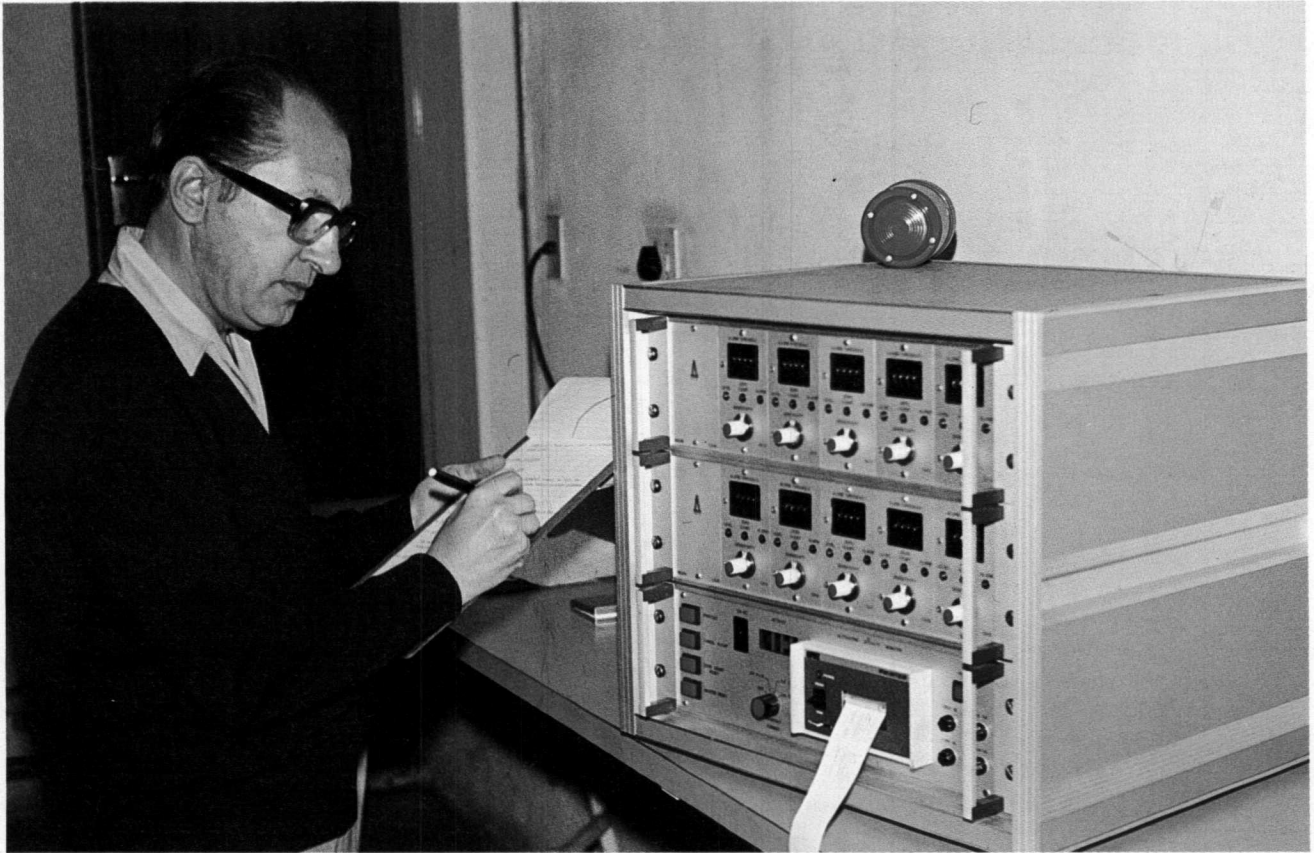
monitoring does not allow of prediction of the toxicity of complex wastes where interacting components may constitute a serious hazard.

Against this background it becomes clear that a biological monitoring system which is continuously in operation can detect such hazardous conditions and provide advance warning of insidious toxic substances in the effluent or reclaimed water.

The NIWR in collaboration with



A general view of the sensor chambers housing the fish.



Mr Steve Morgan of the National Institute for Water Research studying the printout reflecting the activity of the fish in the sensor chambers. The system utilises ultrasonic echoes to measure the activity of fish in sensor chambers. Potentially hazardous situations may be recognised at an early stage (the red alarm in the picture will provide early warning) and steps may then be taken to prevent pollution of the environment or the passage of toxic substances into domestic water supply systems.

the NEERI of the CSIR have since 1971 been investigating methods of monitoring water quality by means of biological sensors.

Interest centred particularly around reclaimed water and industrial wastewaters discharged into rivers and dams.

Tests

Laboratory tests soon proved the feasibility of using behaviour patterns of certain types of freshwater fish to detect changes in water quality. The research scientists, WSG Morgan (NIWR) and PC Kühn (NEERI), had shown in 1974 that the presence of even minute quantities of heavy metals (cadmium, copper, lead, mercury, zinc) and pesticides caused a marked deviation in the rhythm of gill movement, heart rate and relative activity of fish.

Continuous electronic monitoring of one or more of these functions therefore allows early detection of potentially hazardous situations and consequently timeous steps may be taken to prevent either pollution of the environment or the passage of toxic substances into



domestic water supply systems. It may be worth noting that the fish normally suffer no harm owing to early indications that they are subject to stress conditions – which call for immediate action to divert the flow.

Apart from continuous monitoring the system offers other advantages, inter alia:

- The fish react to the total effect the effluent or reclaimed water will have on the environment.
- Since only a single function need be monitored (e.g. activity) the instrumentation required is relatively uncomplicated and inexpensive.
- Once installed, the system operates automatically and require little attention.

The activity monitoring system has proved to be most successful in industrial applications and it is this type which has been installed in the industries and water reclamation plants referred to in the introduction to this article.

The system developed by Kühn and Morgan utilizes ultrasonic echoes to measure the activity of a single fish in a sensor chamber through which passes a continuous

(To page 4)

Biomonitoring system

(From page 3)

stream of test water. There may be five or ten sensor chambers in the system, each fitted with an ultrasonic transmitter and receiver.

The signal which is emitted from the chamber comprises the sum of the various reflected sound waves coming off the body of the fish as it moves around. These reflections are processed to the point where the activity counters record the movements of the fish.

Alarm

The system monitors and records the activity of each sensor fish, and measures this activity against an adjustable critical level (explained below). If the activity of the sensor fish exceeds that level, a response is recorded for the particular channel and a red warning light is activated. Whenever any three of five sensors (or any predetermined number) elicit a response, a sound alarm signal is generated. The effluent or reclaimed water is automatically then diverted until analyses have indicated the source of the problem. The data obtained from each sensor chamber are recorded hourly on printout, or manually on demand.

To allow acclimatization to enclosure, each sensor fish is kept in the chamber for 48 h before any activity is recorded. Normal activity levels are then recorded for a period of seven days (not in test water) and used to calculate mean values and standard deviations for each hour of the day and night.

Critical

The hourly records are then used to determine 95% confidence limits for activity, and the highest of these is considered to be the critical response level for the sensor fish concerned.

The fish species used in this system has been the guppy (*Poecilia reticulata*). This species is not only sensitive to a large variety of pollutants, but it can also easily be reared in a laboratory. The fish in the sensor chambers are re-



Nutrient removal

NEW TECHNICAL GUIDE OUT

A new publication *Technical guide on biological nutrient removal: the phoredox process* has just been published. This guide was prepared for the Water Research Commission by MJNP Simpkins and A Gerber of the National Institute for Water Research (NIWR) of the CSIR.

Increasing awareness of the need to prevent excessive eutrophication in impoundments and other water resources has stimulated research into ways and means of removing plant nutrients, particularly nitrogenous and phosphorus compounds, from sewage effluents prior to their release into the water environment. The NIWR developed the Bardenpho process for the biological removal of these nutrients which does not rely on external chemical additions while requiring little extra energy input.

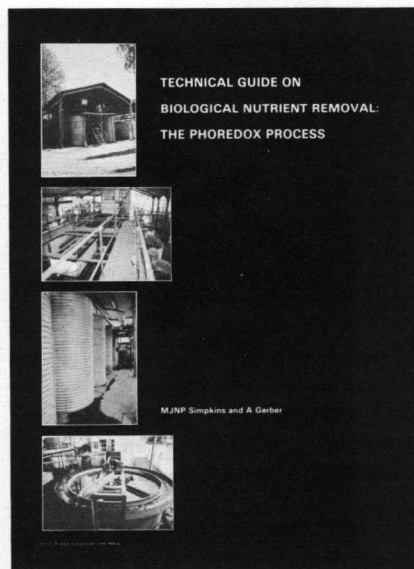
Phoredox

This process, which was patented worldwide, has since been superseded by the Phoredox process which is described in detail in this new publication. The guide represents research conducted in this regard at the NIWR with financial support from the Water Research Commission over a period of five years.

This publication is intended primarily as a guide to the design and operation of the Phoredox pro-

cess. It provides designers and planners with performance and design data on which to base their decisions.

The Phoredox process falls within the ambit of the Bardenpho patent (No 72/5371) and hence it has been necessary to protect the marketability of the latter by deleting detailed and explicit design information from the main text of this publication. The latter information may be obtained by arrangement with the patent holders, Messrs SAIDCOR, PO Box 395, Pretoria.



● The Technical Guide referred to in this article.

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TT publication

Research carried out by the NIWR on the Phoredox process forms part of a larger research programme coordinated and partly financed by the Water Research Commission on the optimization of the modified activated sludge process for nutrient removal, undertaken jointly by the NIWR, the City Council of Johannesburg and the Universities of Cape Town and Pretoria. A technology transfer publication on the findings of the overall programme is currently being compiled and should be ready for distribution in 1983. Readers will be duly notified of the availability of this publication.



Technology transfer:

OPEN DAY AT ST HELENA

One of the most important functions of the Water Research Commission is the dissemination of knowledge with respect to water research and its application. The application of research results normally represents the final dividend in the WRC's research investment.

As part of this technology transfer programme, the Water Research Commission recently arranged a demonstration of the pilot dissolved-air flotation plant at Suid-Oranje Fisheries, St Helena Bay.

Despite the adverse weather conditions more than forty invited guests from the fishing and fruit and vegetable industries attended the demonstration to observe the operation of a dissolved-air flotation plant processing a mixed effluent.

The chairman of the WRC, Dr MR Henzen, opened the proceedings by welcoming the guests to St Helena Bay. He briefly sketched the Water Research Commission's involvement in the water and effluent management problems facing the fishing and fruit and vegetable processing industries. (See *SA Waterbulletin*, May 1982 and August 1982.)



Mr TL Boshoff of the firm of consulting engineers who conducted the research on behalf of the WRC explained and discussed the dissolved-air flotation process. This was followed by an inspection tour of the plant.

The principles of flotation

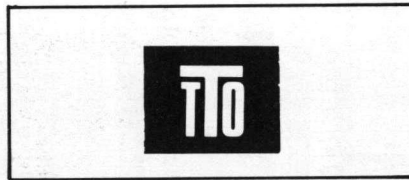
The effluents from fish processing plants derive their organic content from fats and proteinous substances, leached or expelled

during handling and processing of the fish. Contact between fish and water is unavoidable which means that if pollution of processing effluent-receiving waters is to be avoided, a method must be found to separate the pollutants from the water. The pollutants so separated are useful substances and can be returned to the fish meal and oil process thereby increasing the yield and hence profitability of the entire process.

As the contaminants present in the effluents are more prone to float than to settle, the process of separation becomes one of improving the efficiency of the naturally-occurring floating process. To

(To page 6)

The Chairman of the Water Research Commission, Dr MR Henzen (left) and Commission member Prof DJ Schoeman, pictured at the pilot flotation plant during the open day at St Helena when the fisheries effluent treatment system was inspected.



(From page 5)

achieve this, minutely-divided air bubbles are injected into the effluent flow so that they may assist the flotation process. Air may be induced into the effluent flow at near-atmospheric pressure (induced air) to assist flotation or may be dissolved under pressure which when released will result in a vigorous stream of bubbles which will float the debris and fats to the surface of a suitably designed flotation tank from which it can be separated from the effluent and recovered for processing.

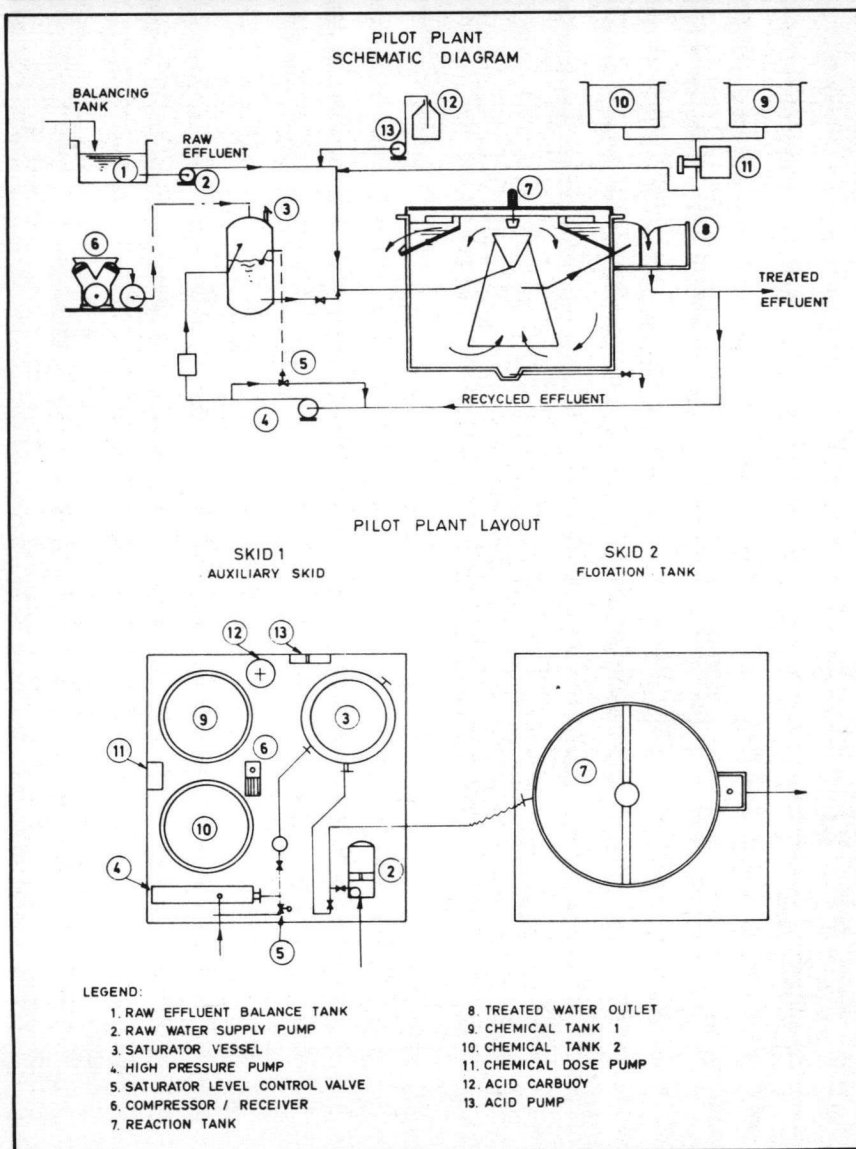
Points of particular note in the design of flotation plants are:

- the method of dissolving the air into the effluent stream
- the distribution of flow in the reaction tank
- the path of the treated effluent from the inlet to final outlet.

The pilot plant

Referring to the schematic diagram, the effluents from the various parts of the plant are passed to a holding tank – 1 – which balances the flow and organic strength to near-constant values which permits the plant to be sized to the average flow over 24 hours rather than the peak flow. The effluent is abstracted by supply pump – 2 – which forwards it to the reaction tank – 7. A portion of the flow which can be recycled effluent or clean sea water is passed from weir box 8 to high-pressure pump – 4 – which raises it to a saturation pressure of 600 kPa and passes it into the saturator tank – 3. The level in tank – 3 is maintained by a level control float which operates a by-pass valve 5 around high pressure pump 4, increasing the flow by-passed if the level in the saturator tank is too high and vice versa if it is too low.

The air-compressor – 6 – delivers air to the saturator vessel 3 where it dissolves into the water which leaves the vessel to join the main stream from the supply pump before entering the reaction tank 7. On entering the tank where the pressure reduces to atmospheric, the air bubbles come out of solution to form a rising stream which floats the oils and debris to the sur-



face for removal by the rotating scraper. Once separated the effluent falls to the bottom of the tank passing under a skirt into the outlet pipe which discharges over an adjustable weir to maintain the water level in the tank and then leaves via weir box 8. Facilities are provided for dosing up to 2 chemicals—tanks 9 and 10 and pump 11 and for addition of acid from carbuoy 12 via pump 13 should chemical dosing be desired.

The plant has been operated on effluents originating from dry and wet offloading systems and canneries; both pilchard and anchovy effluents have been treated.

The plant has shown that it is capable of removing up to 60% of

the chemical oxygen demand (COD) and the suspended solids (SS) in the effluents where typical influent concentrations of those parameters are up to 20 000 mg COD/l and 3 000 mg SS/l; the plant has operated on effluent with concentrations of up to 92 000 mg COD/l having 30 000 mg SS/l. The yields of sludge vary but seem to approach the equivalent of 0,5 kgs dry sludge per kg COD removed without chemical dosing; values as high as 0,9 kg/kg COD removed seem to have been achieved when dosing about 500 mg/l of acid.

A preliminary analysis of the sludges produced from dry offloading and cannery effluents without chemical dosing show the following analysis:

protein	14%
oil	72%
moisture	12%
other	2%

Preliminary economics

Considering a processing factory discharging 30 kg COD/t of fish processed, the additional sludge yield would likely approach 9 kgs per ton of fish processed. For a processing plant operating from January to August handling 74 000 tons per season 660 tons of product valued at about R333 000 would be produced using the low values found for COD rejected and sludge yield; higher values could be achieved by acid dosing.

NEW DEPUTY MINISTER FOR WATER



In this column readers are invited to meet the new Deputy Minister of Environment Affairs and Fisheries, the Hon JWE Wiley, MP.

John Walter Edington Wiley was born on 7 February 1927 at St James in the Cape. He was educated at the Diocesan College (Bishops), Cape Town, and after completing the BA degree (Law) at UCT, he obtained a BA (Honours Jurisprudence) and an MA at Oxford University.

Before being elected Member of Parliament for Simon's Town in 1966, he held professional positions as attorney (1954-56) and advocate (admitted in 1963). As MP Mr Wiley has served on various Select Committees such as Pollution, Defence, the Constitution, Fisheries, and Railways and Harbours.

As a cricketer he represented the Western Province in the Nuffield XI, UCT, SA Universities, Oxford and Western Province. He is also keenly interested in private investment, international affairs and nature conservation, and travelling.

Mr Wiley is married to Jeanne Niehaus and has two sons and a daughter from a previous marriage.

SA Waterbulletin wishes the new Deputy Minister success with the new responsibility entrusted to him.

SOUT IN WES-KAAPSE RIVIER BESTUDEER

(Van bladsy 1)

riviere wat veral onder die soeklig gekom het, was die Vis- en Sondagsrivier in die Oos-Kaap en die Breërivier en die Bergrivier in Wes-Kaapland.

In Augustus 1980 het die Waternavorsingskommissie 'n werksessie in Pretoria oor mineralisasie aangebied: *Understanding Mineralisation Processes*. Dié werksessie

het 'n geleentheid geskep waar die bevindings en die onbeantwoorde vrae van die Werkgroep vir Mineralisasie se huidige en afgelope programme indringend ontleed kon word. Daar is ook na toekomstige navorsingsbehoefte oor mineralisasie gekyk. Op grond van die groepbesprekings, referate en gevolgtrekkings is besluit dat die toekomstige navorsingsbehoefte met betrekking tot mineralisasie in twee kategorieë gegroepeer kon word:

- Navorsingsprogramme spesifiek gerig op die omskrywing en versterking van die fisiese betekenis van konseptuele komponente en die parameters van die model wat deur die WNNR vir die Visrivier ontwikkel is, en die vermindering van die afhanklikheid van dié model van groot-skaalse konseptualisering.
- Navorsingsprogramme wat uitgevoer moet word om antwoorde te verskaf op die volgende vrae:

- Wat is die totale soutbalans van 'n opvanggebied? Wat is die belangrikheid van die litostratigrafiese/hidrogechemiese verhoudings met betrekking tot hul invloed op die soutvrag van riviere?
- Wat is die rol van alluviale soutaansamelings langs rivierkanale in teenstelling met dieperliggende soutbronne in die bodemrots waardeur grondwater in sirkelbane beweeg vanaf omliggende aanvullingsgebiede?
- Wat is die interaksie tussen besproeiingsterugvloei en natuurlike grondvog en grondwater in die strata rondom en onderkant die besproeiingsgebied.

Die WNK het by die werkgroep 'n versoek aan die samewerkers gerig om konsepvoorstelle vir navorsingsprogramme binne die voorgenoemde raamwerk op te stel.



'n Algemene blik op die Poesjenelsrivier vallei waar die navorsing gedoen word.

In een so 'n dokument deur mnr R W Arnold van die Direktooraat van Waterwese getiteld *Motivation for detailed hydrogeological investigations in the Fish/Sundays River catchments in the Eastern Cape and in the Breë River catchment in the Western Cape* is voorgestel dat die Universiteit van Stellenbosch 'n geskikte inrigting sou wees vir 'n geohidrologiese navorsingsprogram in die Poesjenelsrivier-opvanggebied van die Breërivier-vallei.

Ondersoeke wat tot dusver in die Poesjenelsrivieropvanggebied gedoen is, sluit onder meer in die chemiese ontleding van grondwatermonsters uit bestaande boorgate, asook die ontleding van die natuurlike tritium-inhoud van die water in 'n paar uitgesoekte boorgate om die ouderdom van die water te probeer vasstel. Uit die chemiese ontledings het dit duidelik geblyk dat die Witteberg en Bokkeveldgroep-gesteentelae besondere hoë soutladings verskaf aan die grondwater wat daardeur migreer. Die Tafelbergsandsteen-bergmassas daarenteen bevat weer water van 'n hoë gehalte. Die ouderdom van die water in die valleigebiede wat uit Bokkeveldskalie bestaan, is ook heelwat jonger as dié in die sandsteen van die berge. Hierdie feit beklemtoon die besondere hoë soutleweringspotensiaal van die Bokkeveldskalielae oor 'n relatief kort termyn.

Ondersoek het verder getoon dat daar op 'n paar plekke besproei word met grondwater wat hoë soutvragte dra. Versouting op enkele plase was so erg dat die boorgate toegestop is en die grond na twintig jaar nog nie behoorlik herstel het nie. Besproeiingsterugvloei uit sulke gebiede dra ongetwyfeld by tot die mineralisasieproses maar die presiese omvang van die bydrae is nog onbekend.

Talle vrae

Ten spyte van al die werk wat reeds in die Poesjenelsgebied gedoen is, is daar nog talle vrae wat beantwoord moet word. Só byvoorbeeld is die verspreiding van soute op 'n vertikale snit vanaf die grondoppervlak tot in die vaste bodemrots onbekend. Die beskikbaarheid van hierdie soute vir ioon-



Mnr Johan Greeff, projekteier, besig om watermonsters te neem.

uitruiling en opname deur grondwater en elk van die verskillende horisontale eenhede (grond, alluvium, grenslaag, verweerde bodemrots en vaste bodemrots) is ook onbekend. Die snelheid waarmee grondwater deur die verweerde en vaste bodemrots migreer asook die volume wat tot in die rivier vloei, moet nog vasgestel word, terwyl die poreusheid en deurlaatbaarheid van hierdie materiale ook nog nie bepaal is nie. Die verspreiding en invloed van nate en verskuiwings is onbekend asook veranderinge van die grondwatertafel vanweë besproeiing. Verder moet die volume en die snelheid van beweging van grondwater vanuit die aangrensende, hoërliggende berglandskap na die rivier vasgestel word, asook watter uitwerking die toediening van besproeiingswater op die mineralisasieproses het.

Die toediening van groot volumes lae T.O.S.-water aan besproeiingsgronde op skalieagtige bodemrots kan byvoorbeeld groot hoeveelhede soute uit die verweerde materiaal mobiliseer, maar hierdie aspek is nog glad nie ondersoek nie.

In die nuwe WNK-navorsingsprojek sal die Universiteit van Stellenbosch veral die klem op die

volgende aspekte laat val:

- Vasstelling van die soutleweringspotensiaal van bodemformasies langs vyf geselekteerde profiele in die Poesjenelsrivier-vallei wat strek vanaf die rivierkanaal en alluviale gronde tot in die hoërliggende heuwelterrein. (Die profiele word beoog deur onversteurde gedeeltes sowel as besproeide gedeeltes van die opvanggebied)
- Bepalings van die grondwatertafel en die migrasiesnelheid van grondwater deur die onderskeie formasies in die vallei.
- Bepaling van die ligging en relatiewe belangrikheid van alluviale souteansamelings en teenstelling met diepliggende bronne waardeur perkolerende grondwater die rivierkanaal bereik.
- Bepaling van die eienskappe van die grondlae dieper as 1,5 meter in die teenwoordigheid van besproeide gedeeltes, en toetse om die mobilisering van soute vas te stel.
- Die integrasie van bogenoemde resultate en bevindings met die wiskundige modelleringsprogram van die Poesjenelsrivieropvanggebied soos deur die Departement van Landbou geïmplimenter word.

Bulking of activated sludge:

3 ONE-DAY COURSES IN MAY '83: INVITATION

Bulking of activated sludge is a problem commonly experienced in many, if not all, of South Africa's activated sludge plants. An international specialist on this subject, Professor David Jenkins, Professor of Sanitary Engineering at the University of California, Berkeley, USA is to visit the RSA in May next year at the invitation of the Water Research Commission and will be presenting one day courses on the control of activated sludge bulking.

The courses are being arranged in collaboration with the South African branch of the Institute of Water Pollution Control. They are tentatively scheduled for: 9 May 1983 in Johannesburg, 11 May 1983 in Cape Town and 20 May 1983 in Durban. The cost to attend

the course will be of the order of R10 per person to cover lunch and the hire of the course venue.

The course is specifically aimed at sewage works personnel who have to deal with sludge bulking problems, i.e. works superintendents, chemists and operators. Professor Jenkins will briefly deal with the fundamentals of sludge bulking, the identification of bulking micro-organisms, and various ways and means of controlling sludge bulking. A substantial portion of the course time will be used for discussions, i.e. for course participants to set out problems they are experiencing with sludge bulking, how they deal with these problems and suggestions by Professor Jenkins for possible new

avenues to explore and overcome these problems.

In order to assist the Water Commission and the Institute in the planning of these courses please fill in the postcard marked "A" and mail to: The Chairman (Attention Dr H N S Wiechers), Water Research Commission, P O Box 824, Pretoria 0001. Further information can also be obtained from the following persons:

IWPC (Johannesburg):
Mr A R Pitman (011-728-7373)
IWPC (Cape Town):
Mr H Nel (021-97-6181)
IWPC (Durban):
Mr H Mercer (031-28-7171)
WRC (Pretoria):
Mr H N S Wiechers
(012-28-5461)

Sewage purification processes for nutrient removal:

5-DAY COURSE PLANNED

The Water Research Commission has sponsored research on nutrient removal from municipal wastewaters for just under ten years. The work has now reached a definitive stage, and for this reason as well as the urgent need expressed by local authorities and consulting engineers for knowledge on the latest findings and results of research, two technology transfer publications are currently being compiled, viz.

- *Planning, Design and Operation of Nutrient Removal Activated Sludge Plants*, and
- *Chemical Removal of Phosphates from Municipal Wastewaters*.

It is hoped that these publications will be ready for distribution within the first half of 1983.

In order to facilitate direct contact between users of the information contained in these publications and the researchers and practitioners who compiled them, the Water Research Commission is currently planning a short course on the theory, design and operation of sewage purification processes for the removal of nutrients, based on these publications.

It is tentatively planned to hold the course over a five day period, during July/August 1983 in Pretoria. The course will deal in-depth with the theory, design and operation of sewage purification processes for nutrient removal. It will be directed at municipal and consulting engineers, municipal chemists and others concerned

with the design and control of wastewater treatment plants. Participants will be required to attend tutorial sessions every afternoon which will be oriented towards the solution of typical design and control problems. Cost associated with the attendance of the course will be of the order of R50.00 per person to cover lunches and the hire of course venue.

In order to assist the Commission in the planning of this course we need to know the number of persons who would be seriously interested in attending the course. Please let us know as soon as possible whether you are interested in attending this course by completing postcard "B" (see p. 34) and returning it to: The Chairman, attention Dr H N S Wiechers, Water Research Commission, P O Box 824, Pretoria 0001.

INVITATION

POST CARD

Postage
Stamp
Required

**The Chairman
(Attention: Dr HNS Wiechers)
Water Research Commission
P O Box 824
PRETORIA
0001**

Insert to 'SA Waterbulletin' Nov. 1982

I am interested in attending the one day course on **THE CONTROL OF ACTIVATED SLUDGE BULKING** in Johannesburg* /Cape Town* /Durban* and would like to receive further information:



Name:

Position:

Organisation:

Address:

.....

.....

Tel. No.:

Postal Code:

*Delete those which are not applicable.

I am interested in attending the 5 day course on **THE THEORY, DESIGN AND OPERATION OF SEWAGE PURIFICATION PROCESSES FOR THE REMOVAL OF NUTRIENTS** and would like to receive further information.



Name:

Position:

Organisation:

Address:

.....

.....

Tel. No.:

Postal Code:

POST CARD

Postage
Stamp
Required

**The Chairman
(Attention: Dr HNS Wiechers)
Water Research Commission
P O Box 824
PRETORIA
0001**

Insert to 'SA Waterbulletin' Nov. 1982

Rioolwatersuiwering

'N LEKEBENADERING TOT FOSFAATVERWYDERING*

deur JM Pienaar Pr. Ing

Direkteur Tegnieste dienste Administrasieraad Hoëveld

Die Minister van Waterwese, Bosbou en Omgewingsbewing het op 1 Augustus 1980 by wyse van Staatskennisgewing nr. R1567, die Standaarde vir Nywerheidsafvalwater en Uitvloeisel gewysig. Hiervolgens word 'n beperking van 1 mg/l geplaas op die konsentrasie van oplosbare orthofosfate (as P) in afvalwater of uitvloeisel wat vanaf nywerhede afloop na enige gedeelte of sytakke van die volgende riviere:

- *Vaalrivier* stroomop en met insluiting van Bloemhofdam;
- *Pienaarsrivier* en *Krokodilrivier* stroomop van hul samevloeiing;
- *Groot Olifantsrivier* stroomop en met insluiting van Loskopdam;
- *Umgenirivier* stroomop van die invloed van getywater;
- *Umlaasrivier* stroomop van sy uitmonding in die see;
- *Buffelsrivier* stroomop en met insluiting van Bridle Driftdam;
- *Bergrivier* stroomop van getywater.

Volgens wet word 'n riool-suiweringswerk beskou as 'n nywerheid en by implikasie het bogenoemde afkondiging die effek dat die rioolsuiweringswerke in die bevolkte gebiede van die land onderhewig is aan hierdie beperking op oplosbare orthofosfaat.

Eutrofikasie is 'n term wat gebruik word om die trofiese ontwikkeling of selfonderhoudende voedingstoestand van 'n ingeslote watermassa te beskryf en behels spesifiek 'n toestand wat gunstig is vir die groei van plantegroei van die water met natuurlike voeding-

(Na bladsy 12)



Mnr J M Pienaar, die outeur van hierdie artikel, en sy gade afgeneem tydens die IMIESA-kongres in Durban vanjaar.

* Uittreksel uit 'n referaat wat vroeër vanjaar tydens die Imiesa-kongres in Durban gelewer is.

Fosfaatverwydering

(Vanaf bladsy 11)

stowwe. Waar die term tot so kort as 'n dekade gelede 'n relatief onbekende woord was, selfs in die algemene Wetenskap, het eutrofikasie in die jongste tyd soveel betekenis gekry dat selfs die gemiddelde man op straat nou 'n begrip daarvan het. Waar eutrofikasie in werklikheid 'n natuurlike proses is, word die woord vandag meer algemeen gebruik in die sin van versnelde ver-ryking deur die kunsmatige toevoeging van voedingstowwe.

Die florerings van plantweefsels op 'n eutrofiese watermassa is 'n ekologiese balans wat ontstaan het uit die versteuring van die tempo van toevoeging van voedingsmateriaal. Hierdie balans sal ver-ster word indien daar 'n verandering ontstaan in die balans tussen die tempo van produksie en die vernietiging van die plantweefsels. So ook moet die balans tussen fotosintese en respirasie behou bly. Solank as fotosintese en respirasie in balans bly, sal organiese materiaal ontbind word so vinnig as wat dit geproduseer word. Dit is duidelik dat al hierdie voorwaardes nie nagekom kan word in 'n kunsmatig ver-rykte ekosisteem nie en wantoestande ontstaan. Deur 'n relatiewe verhoging in die toevoeging van anorganiese voedingstowwe ontstaan eutrofiese toestande met die gevolglike toename van alge en plante. Deur 'n relatiewe verhoging in die toevoeging van organiese materiaal ontstaan heterotrofiese toestande en 'n ommeswaai in die voedselketting, sodat beskikbare suurstof uitgeput kan raak. Hierdie toestand kan ook ontstaan wanneer die ontbindingsproses die produksieproses domineer. Al hierdie gevolglike wantoestande wat kan ontstaan is dikwels 'n groter erger-nis as wat die oorspronklike pro-bleem van plantweefselopbloeiing was. Benewens die sosiale erger-nis wat dit skep, soos die be-perkings op watersport en ont-spanning, skep die probleem ook aansienlike ekonomiese implikasies

veral by watersuiweringsaanlegte en hou dit verder 'n gevaar in vir waterlewe weens die uitputting van opgeloste suurstof.

Die totale hoeveelhede voedingstowwe wat deur 'n biologiese eenheid opgeneem word, word bepaal deur die maksimum hoe-veelhede voedingstowwe wat deur die eenheid se selmassa ingesluit kan word. Die sellulêre verhouding

"Eutrofikasie het soveel betekenis gekry dat selfs die gemiddelde man op straat nou 'n begrip daarvan het"

van koolstof: stikstof: fosfor van mikrosiste in natuurlike waters wissel van spesie tot spesie. In die mikro-organisme wat in rioolwater-suiweringsprosesse aangetref word, is hierdie verhouding gemid-deld 106:16:1 en in plankton 41:7:1. Aangesien koolstof in feitlik onbeperkte hoeveelhede beskikbaar is, beide uit die at-mosfeer en in opgedamde waters, is die aandeel daarvan in hierdie verhouding egter nie van veel belang nie. Die gemiddelde ver-houding van stikstof: fosfor van alge in natuurlike waters is 15:1. Aangesien hierdie verhouding on-geveer 4:1 beloop in die uitvloeisel vanaf rioolwatersuiweringswerke, sou mens verwag dat stikstof die groeibeperkingselement is. Daar bestaan egter alge-spesies wat die vermoë het om stikstof uit die at-mosfeer te bind, sodat fosfor die beperkende element is. Dit beteken dat die groei van plantweefsel beperk sal word, indien die beskik-bare fosfor beperk word.

Beginnels van Nutriënt-verwydering

Navorsingswerk wat in die ses-tigerjare in Switserland uitgevoer is op nutriënt-verwydering uit aflope het goeie resultate gelewer in die

bekamping van eutrofikasie. In Suid-Afrika was navorsing aan die begin veral toegespits op die ver-wydering van stikstof en sukses op die gebied van fosfaatverwydering en in besonder biologiese fosfaat-verwydering was in sommige ge-valle blote toeval. Nadat dit alge-meen aanvaar is dat fosfate die belangrikste groeibeperkingsele-ment is, het die belangstelling in stikstofverwydering ietwat afge-neem. Huidig word voorkeur ver-leen aan biologiese metodes vir die verwydering van stikstof, alhoewel daar aanvaarde, beproefde che-miese metodes bestaan. Vir fos-faatverwydering word veral in oor-sese lande chemiese metodes ver-kies alhoewel daar ook biologiese verwyderingsprosesse bestaan, wat in Suid-Afrika baie aandag geniet beide in navorsing en toe-passing in die praktyk.

● Fosfaatverwydering

Reeds in 1957 het E Harris waargeneem dat sekere mikro-organismes meer fosfate op-neem as wat die verhouding in hulle selstruktuur sou veronder-stel. In 1965 het Levin en Sha-piro hierdie bevinding ondersoek en hulle noem die verskynsel "weelde opname" ("luxury up-take"). Hulle stel verder vas dat belugting hierdie weelde opname bevorder, maar dat die proses omgekeer word by 'n gebrek aan suurstof. Vir hierdie mikro-or-ganismes sou dit dus moontlik wees om in 'n aerobiese omge-wing 'n oormaat fosfate op te neem om dit dan weer in 'n an-oksiese of anaerobiese omge-wing af te staan. Sederdien het verskeie navorsers die verwy-dering van fosfate in geaktiveer-de slykprosesse waargeneem, dikwels tydens eksperimente met 'n heel ander oogmerk. Die teorie agter hierdie verskynsel is egter nog duister en daar be-staan feitlik net soveel ver-skillende menings as wat daar suksesvolle navorsers is. Wat belangrik is, is dat fosfaatver-wydering in biologiese reaktors wel moontlik is en vir baie in-

Fosfaatverwydering

genieurs wat in die praktyk staan is dit genoeg. Die onduidelikheid wat bestaan, bring dikwels mee dat hierdie prosesse wisselvallig is en gedurige aandag nodig het.

Chemiese prosesse om fosfaat te verwyder behels die omskakeling van oplosbare orthofosfate in onoplosbare fosfaatsoute by wyse van chemiese presipitasie, koagulasie en flokkulasie. Verskeie chemikalieë kan vir hierdie doel aangewend word en die keuse word hoofsaaklik beïnvloed deur beskikbaarheid en ekonomiese faktore. Chemikalieë waarmee sukses behaal word sluit onder andere kalk in asook aluminiumsoute (veral sulfate en chloriede) en ystersoute (sulfate en chloriede). Die vernaamste vereiste vir suksesvolle chemiese verwydering van fosfaat is 'n noukeurige kontrole oor die pH. Chemiese verwydering kan by die primêre besinking gedoen word, of by die finale verheldering waar laasgenoemde ekonomiese voordele inhou. Die vernaamste nadeel verbonde aan chemiese verwydering van fosfaat is die hantering van die resulterende slyk.

● Stikstofverwydering

Stikstof kom in rou rioolwater voor as ammonia en die verwydering daarvan behels óf die verwydering van die ammonia direk óf deur die nitrifikasie van die ammonia tot nitrate en die daaropvolgende verwydering van die nitrate deur de-nitrifikasie. Laasgenoemde proses is gewoonlik biologies van aard terwyl ammoniaverwydering chemies of fisies van aard is.

Die biologiese nitrifikasie behels die oksidering van ammonia tot nitriete deur die werking van die nitrosomonas-bakterie en die daaropvolgende oksidering van die nitriete tot nitrate deur die nitrobacter-bakterie. Albei hierdie bakterieë is outotrofe wat suurstof nodig het vir produksie. Toestande moet geskik wees vir hierdie

bakterieë om te alle tye 'n groeitempo te handhaaf wat minstens gelyk is aan die totale slykproduksie, ten einde te verhoed dat hulle stelselmatig uit die sisteem verdwyn soos die oormaat slyk verwyder word. Die biologiese denitrifikasie van stikstof vind plaas in 'n anoksiese atmosfeer deur die werking van 'n wye verskeidenheid heterotrofe en selfs tot 'n geringe mate deur sekere outotrofe. Alhoewel hierdie laasgenoemde groep 'n fraksie van die stikstof by wyse van assimilatiewe reduksie in die selmassa inkorporeer, word die meeste stikstof in 'n gasvorm verwyder weens die dissimilatiewe reduksie van die nitrate deur die heterotrofe. Die denitrifikasieproses vereis 'n geskikte bron van energie wat beskikbaar is in die organiese koolstof wat in die slyk opgesluit lê.

“Jongste navorsing toon dat belugtingsprosesse baie maklik aangepas kan word vir die verwydering van fosfate”

Chemiese verwydering vind plaas deur die oksidering van ammonia met chloor. Hierdie proses, bekend as “breekpunt chlorering” is egter baie duur aangesien ongeveer 10 mg/l benodig word vir elke 1 mg/l ammonia-stikstof en dit word normaalweg alleenlik gebruik as 'n finale proses wat volg op 'n biologiese stikstofverwydering om enige oorblywende ammonia te oksideer met gepaardgaande ontsmetting.

Die fisiese verwydering van stikstof is moontlik deur die omskakeling van die ammoniumione na opgeloste ammonia-gas by wyse van 'n verhoogte pH en

om die gas dan af te trek deur middel van lugdesorpsie. Die pH kan verhoog word deur die byvoeging van kalk en aangesien die gas nog steeds baie oplosbaar is, word groot hoeveelhede lug benodig. Die kalkbehandeling wat die proses voorafgaan kan moontlik in-eengesakel word met 'n chemiese fosfaatverwyderingsproses.

Huidige Prosesse

Tot sowat 'n dekade gelede het die keuse van 'n rioolwatersuiweringsproses hoofsaaklik gelê tussen biologiese sytelbeddens en 'n geaktiveerde slykproses. Op daardie stadium was die oorweging meer op ekonomiese faktore gegrond en daar is dikwels ekonomiese vergelykings tussen die prosesse gemaak. Die ondersoek was basies gegrond op 'n vergelyking tussen die hoë konstruksiekoste met lae loopkoste van 'n sytelbedproses teenoor die laer konstruksiekoste, maar hoë loopkoste van 'n geaktiveerde slykproses. Soos wat konstruksiekoste en energiekoste oor die jare verander het, het die vergelyking ook verander sodat die geaktiveerde slykproses ten spyte van sy hoë energieverbruik ook in Suid-Afrika meer lonende moontlikhede getoon het. Tot dusver het hierdie proses egter die groot nadeel gehad dat een van sy grootste koste-elemente naamlik kragverbruik 'n onvoorspelbare entiteit is wat in die toekoms baie kan wissel, veral in die lig van die huidige energiekrisis. Die beperking op fosfate het daarenteen hierdie situasie heeltemal verander. Jongste navorsing toon duidelik dat belugtingsprosesse baie makliker aangepas kan word vir die verwydering van fosfate. Die verwydering van fosfate uit sytelaflope kan op hierdie stadium slegs op chemiese wyse geskied, wat onmiddellik ook kostes meebring wat onvoorspelbaar is.

(Na bladsy 14)

Fosfaatverwydering

(Van bladsy 13)

Ten spyte van die onduidelikheid wat daar bestaan oor die teoretiese beginsels van fosfaatverwydering, het ondervinding getoon dat dit wel prakties moontlik is in 'n geaktiveerde slykproses, selfs in volskaalse aanlegte. Deur noukeurige kontrole het die Chemikus van Pinetown vir 'n geruime tyd daarin geslaag om fosfaat en stikstof konsekwent tot baie lae konsentrasies te verminder in 'n eenvoudige reaktor wat nie oorspronklik vir nutriëntverwydering ontwerp was nie.

Die aanvanklike navorsingswerk in Suid-Afrika was veral toegespits op die verwydering van stikstof en in hierdie opsig het veral J L Barnard sukses behaal. Sy werk was spesifiek gemik op 'n kombinasie van die Ludzack- en die Wuhrmann-prosesse. Beide hierdie prosesse maak gebruik van biologiese nitrifikasie-denitrifikasie. Die verskil is egter dat die Ludzack-konfigurasie die denitrifikasie bewerkstellig deur eksogene respirasie, terwyl dit in die Wuhrmann-proses geskied deur endogene respirasie.

Eksogene respirasie kom in baie eenvoudige terme neer op die verwerking van die nitraatmolekules in 'n proses waartydens die organismes hulle energie put uit beskikbare koolstof uit die onmiddellike omgewing. By gebrek aan 'n energiebron vind endogene respirasie plaas. Endogene respirasie kan oppervlakkig beskou word as 'n proses waarin die organismes uitgehonger word tot dat hulle begin doodgaan en so doende 'n alternatiewe energiebron verskaf vir die balans van die organismes wat nog lewe. Dit is duidelik dat endogene respirasie dus 'n baie tydsame proses moet wees, aangesien daar moet gewag word vir die eerste klomp organismes om te begin doodgaan.

Die Ludzack-konfigurasie bestaan uit 'n anoksiese reaktor, gevolg deur 'n aerobiese reaktor met hersirkulasie van die slyk en die rioolmengsel terug na die

anoksiese reaktor. Inkomende ammonia-stikstof gaan feitlik onveranderd deur na die tweede reaktor waar dit in die aerobiese omgewing genitrifiseer word na nitrate. Die nitrate word na die eerste anoksiese tenk gehersirkuleer, waar dit tot stikstof gereduseer word. In hierdie tenk word die inkomende rou riool as energiebron gebruik. Dit is duidelik dat in 'n geslote kringloop nie al die nitrate gehersirkuleer kan word nie. Alhoewel volle nitrifikasie dus moontlik is, is volle denitrifikasie teoreties onmoontlik.

Wuhrmann

Die Wuhrmann-konfigurasie bestaan uit 'n aerobiese reaktor, gevolg deur 'n anoksiese reaktor. Die inkomende stikstof word in die eerste aerobiese reaktor tot nitrate geoksideer en daarna in die anoksiese reaktor tot gas gedenitrifiseer. Omdat die inkomende riool by hierdie punt ook reeds geoksideer is, is daar geen energiebron beskikbaar nie. Aangesien die denitrifikasie dus deur endogene respirasie geskied, wat soveel stadiger is, sou dit beteken dat die anoksiese reaktor buitengewoon groot moet wees – tot so 'n mate dat die veel kleiner aerobiese reaktor nie volle nitrifikasie sal kan handhaaf nie.

Nie een van bogenoemde prosesse is dus ten volle suksesvol nie. Barnard het hierdie probleme probeer oorbrug deur 'n kombinasie van die twee prosesse. In essensie kom sy "Bardenpho"-proses neer op 'n Ludzack-proses gevolg deur 'n tweede anoksiese reaktor. Alle nitrate wat dus nie na die eerste anoksiese reaktor gehersirkuleer word nie, sal dus outomaties in die tweede anoksiese reaktor beland. Uit die aard van die saak sal denitrifikasie in die eerste reaktor deur eksogene respirasie plaasvind, terwyl dit in die tweede reaktor deur endogene respirasie plaasvind. Die tweede anoksiese reaktor sal dus heelwat groter as die eerste een wees.

Dit was tydens sy navorsing op

hierdie gebied dat Barnard ook verhoogde fosfaatverwydering waargeneem het. Hierdie waarneming is uitgebou en het gelei tot die gemodifiseerde geaktiveerde slykproses. Hierdie konfigurasie behels bloot die byvoeging van 'n anaerobiese sone aan die begin van die "Bardenpho"-proses, en werk dus op dieselfde beginsels as die vroeëre gepatenteerde "Phostrip"-proses, naamlik die "weelde opname"-verskynsel.

In die "Phostrip"-konfigurasie word verhoogde fosfaatopname verkry in 'n belugtingstenk. Die finale fosfaat-arm uitvloeisel word dan in 'n verhelderaar geskei van die fosfaatryke slyk wat op sy beurt weer in 'n anoksiese proses van die fosfaat ontnem word om dan weer teruggevoer te word na die belugtingstenk om te help met verdere fosfaatopname. Die afloop vanaf die anoksiese tenk wat nou al die fosfaat in hoë konsentrasie bevat, kan dan op 'n geskikte wyse behandel word. ('n Moontlike behandelingsmetode is die intensiewe aanwending op landerye.)

In die gemodifiseerde geaktiveerde slykproses kan die anaerobiese tenk aan die begin vergelyk word met die anoksiese tenk van die "Phostrip"-proses. Die hersirkulasie-slyk vanaf die verhelderaar staan hier al die fosfate af, net om dit weer verder aan in die belugtingstenks weer op te neem. Die inkomende fosfaat is dus gedurig in die proses teenwoordig, hetsy in die slyk of in die mengsel. 'n Stelselmatige toename in fosfaatkonsentrasies word verhoed deur die fosfaat wat gedurig saam met die oormaat slyk afgetrek word. Teoreties sal hierdie proses dus gereeld dieselfde hoeveelheid fosfaat in die oormaat slyk aftrek as wat in die invloei teenwoordig is.

Benewens die prosesse wat hierbo beskryf is, bestaan daar etlike standaardeenhede en patente wat op dieselfde beginsels bedryf word, soos die "Paasveer", "Orbal" en "Carousel" om maar 'n paar te noem. Vir baie plaaslike owerhede in Suid-Afrika is hierdie name egter

Fosfaatverwydering

betekenisloos en in die volgende maande sal meeste van hulle hulle moet verlaat op die aanbevelings van raadgewende ingenieurs. Baie van hierdie firmas sal hulle bepaald in hulle ontwerpoorwegings laat lei deur die sukses wat behaal was met die "Bardenpho"- en die gemodifiseerde geaktiveerde slykprosesse. Daar moet egter nie uit die oog verloor word nie dat die groot sukses van hierdie prosesse toegeskryf moet word aan hulle vermoë om stikstof te verwyder. Die eerste prioriteit vir rioolwater-suiwering in hierdie stadium is egter die verwydering van fosfate.

Moontlike Gevallestudies

Al die voorafgaande inligting is alles goed en wel, maar beantwoord geensins enige van die kwellende vrae waarmee baie plaaslike owerhede huidig sit nie. Wat gebeur nou? Hoe word daar van hier af verder gegaan? Ongelukkig is die antwoorde nie so voor-die-hand-liggend nie en bestaan daar ook geen vaste reëls nie. Inderdaad is daar ook vir elke eiessoortige probleem of situasie ook nie noodwendig net een ideale oplossing nie.

By die beplanning van 'n rioolwatersuiweringswerke was die eienskappe van die inkomende rou riool nog altyd een van die belangrikste elemente wat 'n rol gespeel het by die ontwerp-oorwegings. Die afkondiging van die nuwe spesiale standaard het hierdie situasie hoegenaamd nie verander nie. Intendeel kan daar gesê word dat in 'n werke wat gemik is op die verwydering van nutriente, die eienskappe van die inkomende rioolwater ongetwyfeld die grootste invloed het.

Soos vroeër reeds verduidelik is, het sekere organismes wat in rioolsuiweringsprosesse voorkom 'n koolstof: stikstof: fosfor verhouding van 106:16:1 in hulle selsamestelling. Indien ons nou die uitsonderlike situasie sou kry waar die samestelling van 'n inkomende rioolwater dieselfde verhoudings

besit, dan sou dit moontlik wees om daardie riool te suiwer, met volle nutrientverwydering, in 'n doodgewone standaard geaktiveerde slykaanleg. In die praktyk is so 'n tipe afloop egter uiters ongewoon en kan mens dit slegs verwag by 'n afloop met 'n groot bron van koolstof, soos 'n brouery. In normale gevalle kan dit verwag word dat die fosforverhouding hoër sal wees, in welke gevalle daar gebruik gemaak moet word van die "weelde-opname"-verskynsel deur die aanwending van 'n Phostrip- of Bardenpho-proses. Dit kan selfs gebeur dat die fosforverhouding so hoog is dat selfs weelde-opname nie al die fosfaat kan verwyder nie en in sodanige gevalle sal daar noodgedwonge chemiese suiweringsprosesse moet aangewend word. Hierdie situasie kan ontstaan wanneer die aflope van kunsmis- of farmaseutiese nywerhede behandel moet word.

Die hele probleem van proses-seleksie word egter baie meer ingewikkeld wanneer daar 'n reeds bestaande aanleg in gedrang kom. Benewens die eienskappe van die rioolloop, kom daar nou ook etlike ander faktore by wat oorweging vereis, soos die aanpasbaarheid van die bestaande aanleg, uitstaande leningskuld, watter gedeeltes in die nuwe aanleg aangewend kan word, ens. In hierdie omstandighede kan dit maklik gebeur dat onnodige kostes en opofferings aan die aanleg-effektiwiteit gemaak word in 'n poging om soveel moontlik van die bestaande aanleg in 'n nuwe aanleg te inkorporeer. Veral in gevalle waar die bestaande aanleg van biologiese sytelbeddens gebruik maak, is hierdie probleem pertinent.

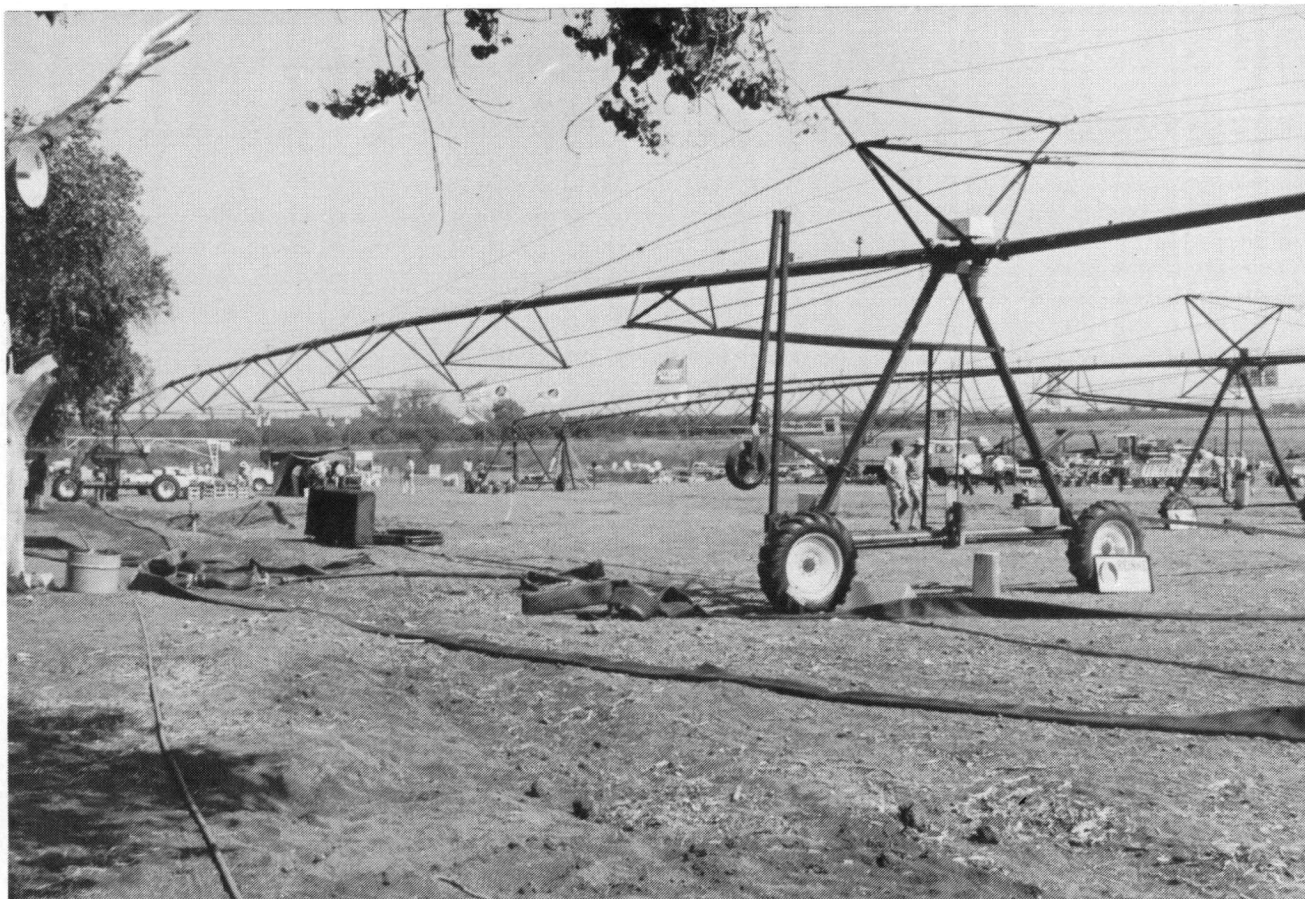
Nou is dit ook so dat meeste suiweringswerke nooit perfek gebalanseerd is vir die vloei wat dit hanteer nie en gebeur dit dikwels dat sekere gedeeltes van die werke oorlaai is terwyl daar reserwekapasiteit in ander gedeeltes oor is. Hierdie situasie kan soms tot groot voordeel aangewend word in 'n aanpassing van die aanleg om

nutriente te verwyder. 'n Eenvoudige voorbeeld hiervan is die omskepping van humustenks waarin daar nog reserwekapasiteit bestaan, in verhelderaars ná die toevoeging van chemiese dosering direk voor die humustenks. Uit ekonomiese oorwegings is dit gewoonlik meer voordelig om chemiese dosering op hierdie punt toe te pas, eerder as aan die begin van die werke. Om chemiese dosering aan die begin van die werke toe te pas, word daar benewens die fosfate ook presipitasie verkry van elemente wat in ieder geval verder in die proses op normale wyse verwyder sou word en dit lei dus tot onnodige vermorsing van chemikalieë asook besinkingskapasiteit. In 'n bestaande aanleg waar daar egter reeds reserwekapasiteit in die primêre besinktenks bestaan, kan chemiese dosering aan die begin van die aanleg dalk 'n lonende uitweg bied.

Riglyne

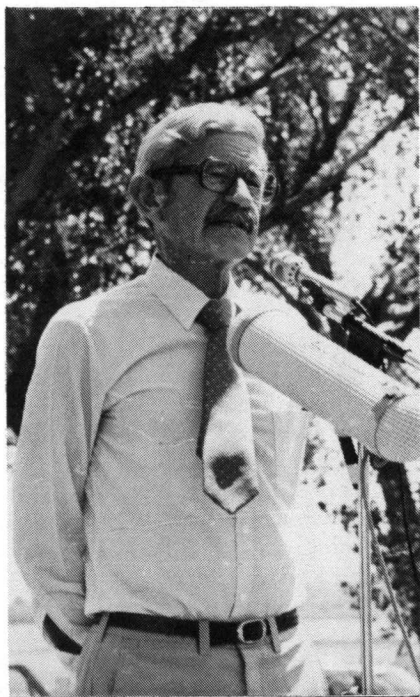
Dit word aanvaar dat sommige lesers na dese nog meer verward is oor die hele aangeleentheid, maar die hoop word uitgespreek dat geslaag is in die doel om aan te toon dat geen voor-die-hand-liggende oplossings vir probleme bestaan nie. Nie alleen is daar huidig geen standaardriglyne vir aanlegontwerp nie, maar kan daar uit die aard van die saak geen sodanige riglyne geformuleer word nie.

Midde-in die fassinerende wêreld van ekologie, chemie, bio-chemie en mikrobiologie staan die besondere veld van rioolwater-suiwering. Hierdie vakgebiede laat hulleself nie voorskryf nie en daarom sal die aanvaarde beginsel dat daar 'n antwoord op elke vraag is nooit in die gebied van rioolwater-suiwering kan geld nie. Elke besonder situasie sal op meriete hanteer moet word en daarom sal plaaslike besture nie kan wegkom van die feit dat hulle die hulp van spesialiste sal moet betrek nie.



Besproeiingsdag te Marble Hall:

Gebruik resultate: Schoeman



Minister Schoeman aan die woord tydens die Besproeiingsdag.

'n Pleidooi vir groter aandag aan die resultate van besproeiingsnavorsing is onlangs deur die Minister van Vervoerwese, Minister Hendrik Schoeman gelewer. Mnr Schoeman het die Loskopse Oes- en Besproeiingsdag op sy plaas Moosrivier naby Groblersdal geopen. Die besproeiingsdag is gereël deur die Loskop-sitrusstudiegroep onder die voorsitterskap van mnr S van Rooyen en is deur 'n paar honderd geesdriftige boere en andere bygewoon.

In sy toespraak het Minister Schoeman gesê dat navorsing die sleutel tot groter produksie in die landbou hou. Navorsing sal in die toekoms die metodes moet ontwikkel waardeur groter lewering verkry sal word per eenheid besproeiingswater toegedien.

Meganisering en outomatisering het reeds by die boer inslag gevind en wetenskaplike boerderymetodes het daarvoor gesorg dat landbouproduksie oor die laaste

dekades gestadig gestyg het. Die tyd het egter nou aangebreek dat indringend gekyk moet word na die aanwending van water — en in hierdie verband sal die boer ook sy kant moet bring, veral by die toepassing van die resultate.

TO-oordrag

Die besproeiingsdag was die eerste stap van die Loskop-sitrusstudiegroep se veldtog om meganisering en die oordrag van tegnologie by die besproeiing van alle gewasse aan die klein- en middelboer bekend te stel.

Uitstallings en demonstrasies van landbouthoerusting, trekkers, implemente, besproeiingstoerusting, chemikalieë, kunsmis, heinings, pompe, mikrospuite en so meer het lewendige belangstelling uitgelok. Lesings oor 'n verskeidenheid landboukundige onderwerpe en van huishoudkundige belang is ook aangebied.

Technikon, Pretoria, bied in 1983:

DIPLOMA IN WATERVERSORGING

'n Nasionale diploma in waterversorging sal vanaf Januarie 1983 op 'n voltydse en/of deeltydse (dag-per-week vrystelling) basis by die Technikon, Pretoria, aangebied word mits die nodige aantal studente daarvoor aansoek doen.

Die doel van die kursus is om 'n breë, grondige opleiding in die praktiese en teoretiese aspekte van waterversorging te verskaf. Dit behels nie alleen die behandeling van water en afvalwater nie, maar ook die veilige wegdoening van behandelde uitvloeisels en vaste afval sonder enige gepaardgaande sekondêre besoedeling.

Hierbenewens dek die kursus ook die analitiese aspekte en beheer- en wetsaspekte wat op alle waterbronne betrekking het. Dit kweek begrip van en waardering vir die hele komplekse hidrologiese kringloop en die versorging daarvan.

Die kursus strek oor 'n minimum van drie jaar wat agtien maande toegepaste indiensopleiding insluit. Dit kan ook deeltydse op 'n dag-per-week vrystellingsbasis aangebied word, in welke geval die student een dag per week by die Technikon deurbring en die ander vier dae by se werkgewer.

Die Kurrikulum vir die kursus behels:

- *Vlak 1*
Chemie WCA111

Chemie Prakties WCC111
Fisika WFJ111
Mikrobiologie WML111
Berekenings en Statistiek WBA111

- *Vlak 2*
Waterversorgingstegnologie WWH211
Wateranalise WW1211
Wateranalise Prakties WWJ211
Mikrobiologie WML211
Besoedelingsbeheer WBX211
Tekene: Chemiese Ingenieurswese WTA111

- *Vlak 3*
Waterversorgingstegnologie WWH321
Wateranalise WW1321
Wateranalise Prakties WWJ321
Waterbiologie WWK311
Beheer- en Wetsaspekte (water) WBY211
Ingenieursaspekte van Waterversorging WIE211

Die Technikon verneem graag van voornemende studente en verdere navrae kan gerig word aan: Die Departementshoof, Departement Toegepaste Chemie, Skool vir Chemiese Wetenskappe, Technikon Pretoria, Kerkstraat 420, Pretoria 0002. Tel (012) 28-3811 x 137/249.

Min. Hayward besoek looiery



Die Minister van Omgewingsake en Visserye, Sy Ed SAS Hayward, het Silvertonlooiery onlangs besoek om die uitvloeiselbehandelingsproses te besigtig. Van links na regs verskyn mnr Basie Heunis, besturende direkteur van die looiery, Minister Hayward, mnr Sarel Roets (met watermonsters), mnr JF Otto, Direkteur-generaal van Omgewingsake, dr MR Henzen, voorsitter WNK, en mnr E. Heunis.

Water stress and evapotranspiration studies for irrigation and crop modelling



by
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Institute,
Private Bag X79,
Pretoria 0001

Understanding and predicting crop water use and water stress is of fundamental importance in irrigated agriculture and for maximising water use efficiency. Research in this field is a major part of the work being carried out by the Agrohdrology Section of the Soil and Irrigation Research Institute in Pretoria. The approach is unique in South Africa as it involves a multidisciplinary team with scientists in plant physiology, micrometeorology and soil science investigating various aspects throughout the soil-plant-atmosphere continuum.

The aims of this project are to understand and predict water uptake and water loss from certain crops as influenced by the soil and atmospheric environment, to identify methods of early detection of crop water stress and to assess the effects of different degrees of stress on crop growth, development and yield. These results will be used in testing and adapting certain research-based irrigation scheduling and crop growth models for simulating and predicting water use in plants and hence for forecasting water use efficiency and crop yield. So far an impressive total of more than 20 publications have originated from the project.

Various crops investigated

Wheat and soybeans have been the main crops investigated for four consecutive seasons, although some research has also been conducted on citrus and potatoes. The field experimental area consists of a 4 ha block under irrigation sited at the Horticultural Research Institute near Pretoria. The citrus orchards are located at the Sundays River Experiment Station near Addo. In order to study the effects of water stress on crop growth and yield two movable rain shelters were constructed, each protecting an area of 12 m × 12 m (Plate 1). The rain shelters are

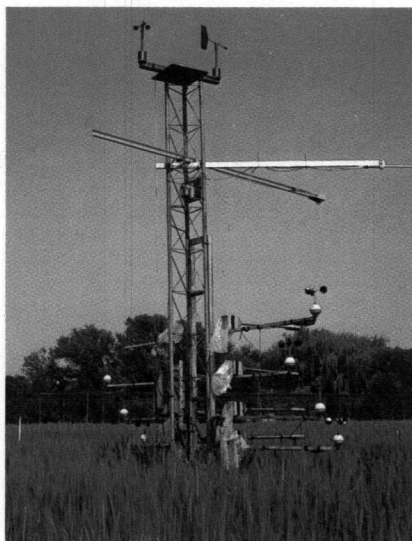
Plate 1: (Left) Moveable rain-out shelter used to keep rain off the field plots thus allowing crop water stress studies. Mr George Green, who initiated this project, and Dr. Wayne Meyer, the previous plant physiologist, can be seen inspecting the soybean plants.

moved over the experimental plots when rain threatens thus allowing control of water applications which is essential in water stress studies.

The role of evapo-transpiration in water use

Understanding water movement and water loss from the soil and plant to the atmosphere is of fundamental importance in all irrigation and crop water use studies. Evapotranspiration is the term used to refer to a combination of these two physically similar processes of water loss by evaporation from the soil and transpiration from crop surfaces. There are numerous com-

Plate 2: A range of sophisticated micrometeorological equipment is located on a tower in the wheat field at various heights above the crop canopy for energy balance studies.



plex physical processes involved in evapotranspiration and because the overall process plays such a central role in crop production, a wide variety of theoretical and empirical equations have been developed which use meteorological data and are based on many assumptions and which may have many shortcomings.

Energy is required to evaporate water from the soil and to cause plants to transpire. The main source of energy for water vapourization is from solar radiation but advection can provide additional energy (in the form of sensible heat that is moved into or out of the area under consideration). Several physiological and environmental factors influence evapotranspiration, including crop height (roughness), stomatal aperture, surface albedo, maturity of the crop and soil water status. Our studies concentrate on various aspects of evapotranspiration in relation to the actual energy balances in and above the canopy, the contribution of soil evaporation

and transpiration and various plant responses to declining soil water.

Actual evapotranspiration can be approximated simply as the product of the potential evapotranspiration and an empirical crop factor. Potential evapotranspiration is defined as the maximum rate at which water could be removed from the soil and plant surfaces of a well-watered crop with complete soil cover like lucerne or pasture. The ratio of evapotranspiration under a given set of conditions and the potential evapotranspiration under this condition is referred to as the crop coefficient or crop factor. Fig. 1 shows how the crop factor for well-watered soybeans

varies with stage of growth during the season depending mainly on leaf area index.

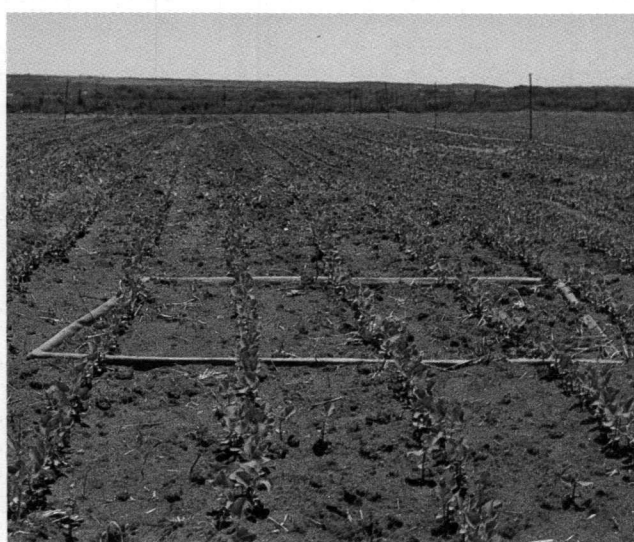
Quantifying the energy balance

The maximum amount of water a crop can lose to the atmosphere is limited by the total energy it receives. The sources of this energy are mainly the sun and the lower layer of the atmosphere that is in contact with the plants. It is important to quantify the energy balance above the canopy by (i) assessing the relative importance of these energy sources, including advected energy (ii) defining radiant energy dissipation patterns, and (iii) relating these to meteorological, plant and soil parameters. The results of energy balance measurements being carried out will be incorporated in a range of crop growth and irrigation scheduling models.

To measure the different parameters needed in this study a variety of equipment has been built and assembled in the field (Plate 2). The equipment includes radiometers, soil heat flux plates and, installed at several heights above the canopy, anemometers and psychrometers. The outputs of the different instruments are processed and recorded on the data acquisition system.

(To page 20)

Plate 3: The lysimeters (left) provide a measure of evapotranspiration and play an integral part in the crop water use studies. The lysimeters on the left are located in a citrus orchard at Addo in the Eastern Cape and contain well established orange trees, whereas the lysimeter (right) is used for annual row crops such as soybeans.



WATER STRESS (continued)

(From page 19)

The importance of soil water evaporation

The measurement of crop water loss to the atmosphere by lysimetric or micrometeorological methods, includes the water lost directly from the soil surface. The object of this study is to assess the relative importance of soil water evaporation, develop a model for its prediction under different crop canopies and investigate its influence on other micrometeorological parameters (e.g. those describing energy partition with the canopy). Techniques are presently being developed for the measurement of the various parameters necessary in this study. These include the construction of special microlysimeters for placement in the soil between the crop rows.

Measuring evapotranspiration with lysimeters

A means of obtaining precise evapotranspiration data is indispensable when studying soil-plant-water relations and developing methods of predicting water use. The most sensitive and direct means of measuring evapotranspiration is by using precision weighing lysimeters with sufficient resolution to permit accurate hourly values to be obtained. Four large (2m x 2m x 1m) precision weighing lysimeters are used at Roodeplaat (Plate 3) to study evapotranspiration and to follow crop depletion of soil water. Use is also made of three further lysimeters located in a citrus orchard at Addo in the Eastern Cape (Plate 3). The lysimeters used for field crops have a mechanical counter-balanced lever system with taring to measure changes in residual mass, and are capable of resolving mass changes of 0,16 kg which is equivalent to 0,04 mm of water. Evapotranspiration is monitored every 20 minutes together with various other environmental

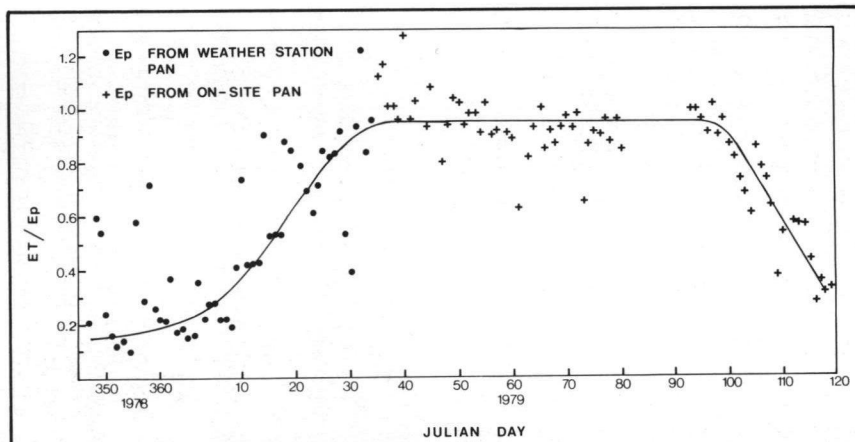


Fig 1: Typical values of the crop coefficient for soybeans used in the irrigated scheduling model to forecast irrigations.

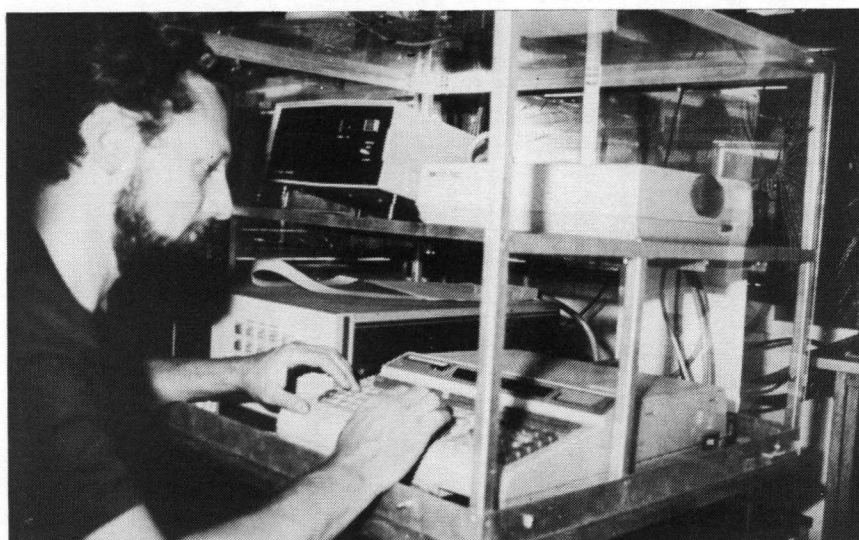


Plate 4: The data acquisition system plays a central role in receiving and storing the large amount of data generated from the field instruments. Mr Pedro Berliner, an agrometeorologist employed by the Water Research Commission seen operating the computer in the system, is mainly concerned with the quantification of energy balances above the canopy, advection, soil evaporation and the infra-red thermometer studies.

Plate 5: The caravan situated alongside the field provides shelter for the data acquisition system as well as other instrumentation used in the field studies. Dr. Derrick Oosterhuis and Mr Pedro Berliner can be seen discussing data in front of the caravan, and Mr Leon Peense, the control technician, is visible working in the field next to the instrument tower.



parameters using an automatic data logging system. Field replication of lysimeter treatments is always attempted by similar irrigation of the areas surrounding the lysimeters. However, great caution is necessary in extrapolation of lysimeter data, particularly as the crop matures, due to the restricted depth of the root system.

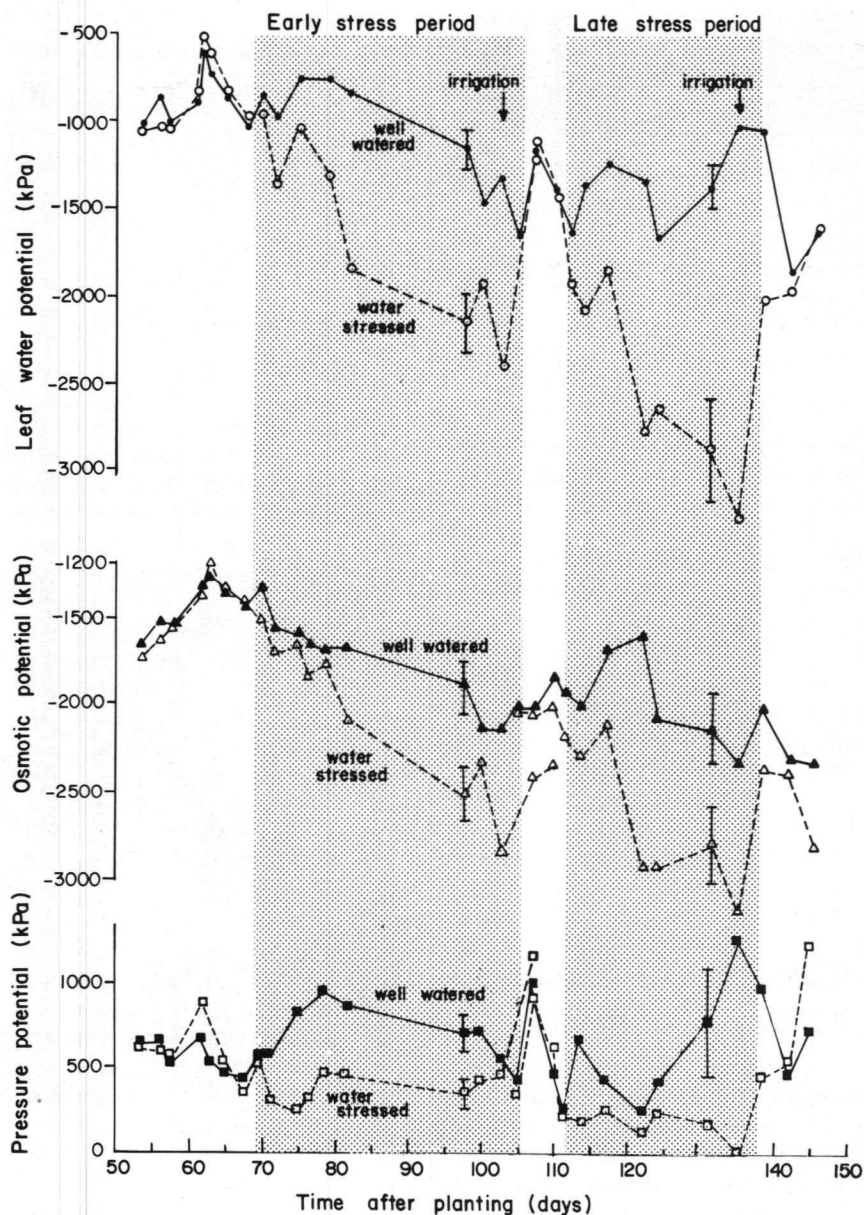
Data acquisition system

A data acquisition system (Plate 4) is located in a caravan alongside the field (Plate 5). The system is capable of accepting 100 channels of analog and digital data. Each channel is measured individually and a scan of all channels is performed every 20 seconds. The data is transferred to a dedicated desktop computer where it is processed. This data is then printed and stored on tape for future use. All the micrometeorological instrumentation and the lysimeters are linked to the data acquisition system.

Measurement of soil and plant water status

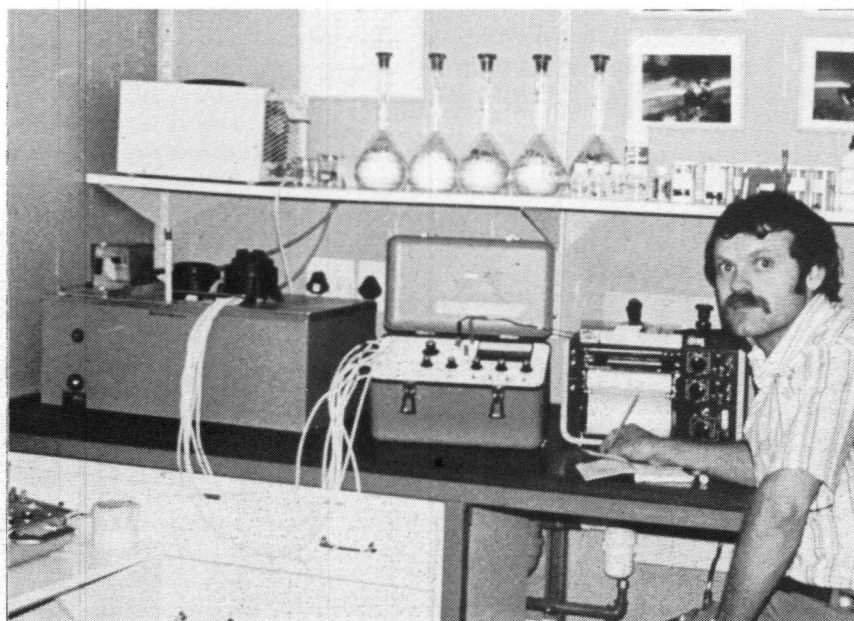
A range of plant monitoring instruments are available including pressure chambers for measuring plant-water potential, thermo-

(To page 22)



(Right) Fig 2: Seasonal changes in components of leaf water potential for well watered control plants (solid symbols) and for water stressed plants (open symbols) in early and late stress periods for field grown wheat.

(Right) Plate 6: The thermocouple psychrometer laboratory plays a central role in all water potential measurements. Dr Derrick M Oosterhuis, the principal researcher and plant physiologist, employed by the Water Research Commission, is involved in a number of the projects and is particularly interested in plant-water relations, psychrometry, components of water potential, water stress, preconditioning and crop modelling.



WATER STRESS

(From page 21)

couple psychrometers for measuring components of water potential, diffusion porometers for recording stomatal resistance, and, leaf area meters and an infra-red gas analyser and radioactive CO₂ applicator for measuring gross photosynthesis. Equipment for monitoring soil water status includes instrumentation for gravimetric determinations, tensiometers, soil psychrometers and neutron probes. Measurements of plant and soil water status are imperative in all evapotranspiration and crop water use studies.

Thermocouple psychrometer laboratory

An intensive effort has been made to extend the capabilities in the sphere of plant water potential measurement by setting up a thermocouple psychrometer laboratory (Plate 6) and optimising field and laboratory techniques for reliably measuring not only leaf water potential, but also its components, osmotic and pressure potential. Leaf samples can now be taken in the field and the measurements conducted back in the laboratory some distance away (up to 100 km). These additional capabilities provide a new dimension to ongoing investigations into the onset and development of crop water stress. The psychrometer labora-

tory also provides a service in many of the other studies in the overall project.

The thermocouple psychrometer laboratory (Plate 6) consists of a constant temperature room housing a range of different commercially available psychrometers and equipment for measuring the thermocouple microvolt output, together with the other equipment necessary for routine cleaning, calibration and maintenance of the psychrometers. Liquid nitrogen facilities are also available for tissue freezing for osmotic potential measurements. The range of thermocouple psychrometers used include screen-caged psychrometers in swagelok chambers (Plate 7), end-window chamber psychrometers, leaf cutter psychrometers, C-52 sample chamber psychrometers and *in situ* leaf hygrometers (Plate 7).

These five commercially available psychrometers were compared against a Scholander pressure chamber (the standard and most popular instrument for measuring leaf water potential), with the screen-caged psychrometer giving the best results. Field use of *in situ* leaf hygrometers for non-destructive and continuous monitoring of leaf water potentials in soybeans is possible provided the necessary precautions are taken. These measurements are more variable, but otherwise compare reasonably with results obtained with screen-caged thermocouple psychrometers and the pressure chamber.

Investigations have also been made into the optimum leaf sample

size for psychrometric measurements using sample chambers, and also into the importance of evaporative losses that occur during destructive leaf sampling prior to psychrometric or pressure chamber measurements.

Seasonal changes

In order to understand and predict the general patterns and changes in plant water status that occur in the field with declining soil water and irrigation, seasonal and diurnal trends have been followed over a number of years for both soybeans and wheat (Fig 2). Routine field measurements included components of leaf water potential measured with psychrometers, covered leaf water potential recorded with a pressure chamber (Plate 8), steady state measurement of stomatal diffusive resistance (Plate 9), leaf elongation and relative water content. Daily measurements of soil matric potential (tensiometers) and weekly records of soil gravimetric water content were also made. Measurements of plant water status have been related to the available soil water and the final yield, and are essential for understanding plant responses to declining soil water between irrigations and also in irrigation scheduling and crop modelling.

Crop water stress

Some uncertainty exists as to how early a stress can be detected in the field and to what extent yield

*Plate 7: Thermocouple psychrometers provide an accurate and reliable measure of water potential and its components. The screen-caged psychrometer, swagelok sample chamber and position of the psychrometer in the chamber is shown on the left. The *in situ* leaf psychrometer on the right enables non-destructive leaf water potentials to be measured.*

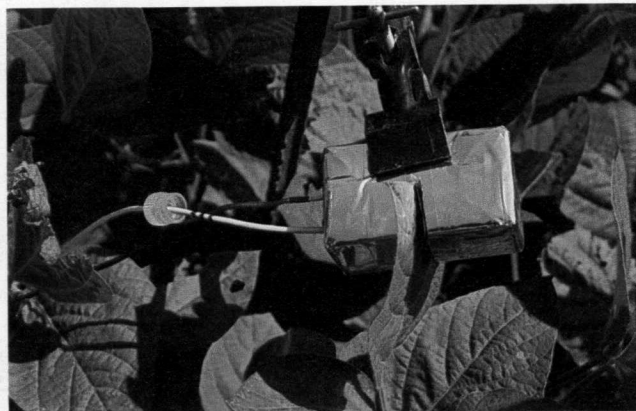
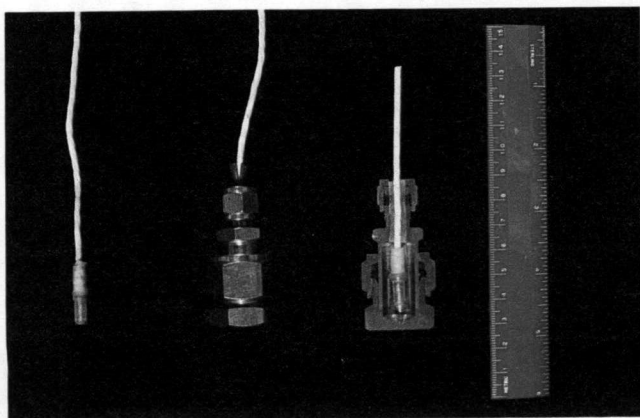




Plate 8: The pressure chamber is the most popular instrument for measuring leaf water potential. Miss Judy Eastham, operating the pressure chamber, is a soil scientist currently working on the response of leaf elongation to water stress, and also studying the importance of soil hydraulic conductivity in modelling.



Plate 9: The steady state porometer provides a new and reliable measurement of leaf stomatal aperture. Miss Sue Walker, an agrometeorologist/plant physiologist is particularly interested in psychrometry and is involved in all measurements of plant water status including the changes that occur after the relief of stress by irrigation.



Plate 10: Thermal insulation of psychrometers inserted in the main trunk and lower branches of a citrus tree for water potential measurement. Variations in trunk diameter are recorded with the LVDT as shown.

may already have been affected. Several years of investigations have been carried out on the early detection and development of plant stress in field crops using commonly available measuring techniques. In these studies the onset of water stress has been defined as the first decrease in evapotranspiration below that of a well-watered crop. This point correlates well with a fixed percentage deficit of plant available water and points at which leaf water potential ψ_L stomatal resistance and leaf elongation are subject to rapid change. Use of ψ_L , as measured with a pressure chamber (Plate 8) or psychrometer, provided the easiest and most reliable means of detecting water stress and monitoring its development. The most sensitive indicator of the onset of stress was covered ψ_L . Components of ψ_L provide more information on the nature of the stress and plant response. After the onset of water stress, leaf pressure potentials are maintained near the well-watered control values for a few weeks by steadily

declining ψ_L . This allows continued leaf growth, but at decreased rates.

Daily values of stomatal diffusive resistance, measured with the steady state porometer (Plate 9) showed less variability than older transient porometers and increased at approximately the same time as ψ_L decreased, making it a useful though less sensitive indicator of the onset of water stress. Canopy temperatures as measured with the infrared thermometer were found to increase at a value of residual PAW similar to that when ψ_L first declined. Soybean leaves change their orientation with the onset of water stress. The possibility of using these leaf movements as indicators of water stress is being investigated in relation to declining plant and soil water potential, and the underlying physiological explanations. Whichever indicator is used, the results need to be interpreted with discretion, taking into consideration plant variability, changes in atmospheric conditions and plant adjustments to stress.

Importance of recovery after stress

The ability of a crop to recover from a mild or severe water stress and the rate of recovery are of great importance in irrigation management and crop water use studies. Previous research on recovery from water stress has been conducted mainly in pots under controlled environmental conditions, but difficulty has arisen in the extrapolation of these results to field conditions.

Field studies at Roodeplaat were conducted on both soybean and wheat crops and involved daily monitoring of various leaf water status parameters (water potential components, relative water content, stomatal diffusive resistance) both before and after irrigation. The ψ_L and stomatal diffusive resistance did not recover immediately following irrigation but took up to a week to achieve values recorded on the well-watered control. For example,

(To page 24)

WATER STRESS

(From page 23)

soyabean Ψ_L recovered in two days while wheat Ψ_L took four days. The Ψ_s remained lower than the well-watered control for longer than a week in both crops, thus maintaining a higher pressure potential enabling rapid growth following the relief of the stress. The degree of osmotic adjustment, indicated by the lowered Ψ_s and the persistence of this condition after irrigation, was related to the severity of the water stress experienced. Results

indicate that the nature of the water stress experienced in the field affects the recovery of plant water status parameters after irrigation, and these effects need to be considered in water use and crop modelling studies.

Preconditioning in relation efficient water use

It has become increasingly evident that plant responses to water deficits depend intimately on their previous growth history, such that plants grown under conditions of water stress become hardened or preconditioned to subsequent stress. Preconditioning results in

lowered osmotic potentials (known as osmotic adjustment), altered stomatal response and changes in many other physiological processes.

It has been necessary to investigate the physiological changes that occur with preconditioning and relate these changes to the ability of the plants to withstand subsequent drought and also to water use efficiency. Both wheat and soybeans exhibited substantial osmotic adjustment under conditions of water stress which resulted in the maintenance of positive pressure potentials necessary for continued cell elongation and growth during the stress period. The persistence of the preconditioned state depended on the severity and duration of the conditioning stress. The ability of a plant to maintain positive leaf turgor potentials as leaf water potential declines is obviously an important adaptation to water deficits.

Leaf elongation and water stress

Successful crop production relies on achieving a suitable photosynthetic leaf surface to produce the necessary assimilate for the commercially important yield. Cell elongation is one of the plant growth processes most sensitive to water stress, and therefore the monitoring of leaf elongation should provide information useful for the early detection of water stress for irrigation scheduling and crop modelling.

Measurements of leaf elongation and Ψ_L were made at the same time daily in the field on both well-watered and water stressed wheat. The daily growth at different water potentials was measured separately as leaf growth and stem growth. Water, osmotic and pressure potentials were also obtained using thermocouple psychrometers.

Threshold values for wheat leaf elongation varied from -19.0 bars in well-watered conditions, to -22.5 bars for previously stressed wheat. The lower value after water stress was due to the plants being "preconditioned" by the stress. This resulted in lower cellular osmotic potentials which allowed

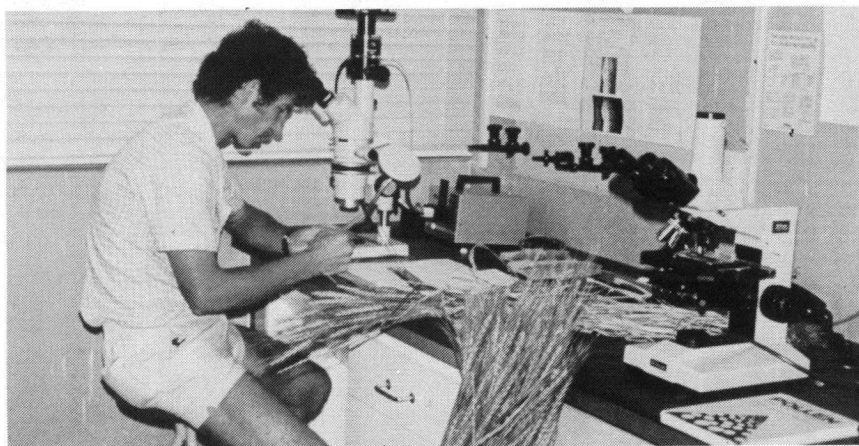
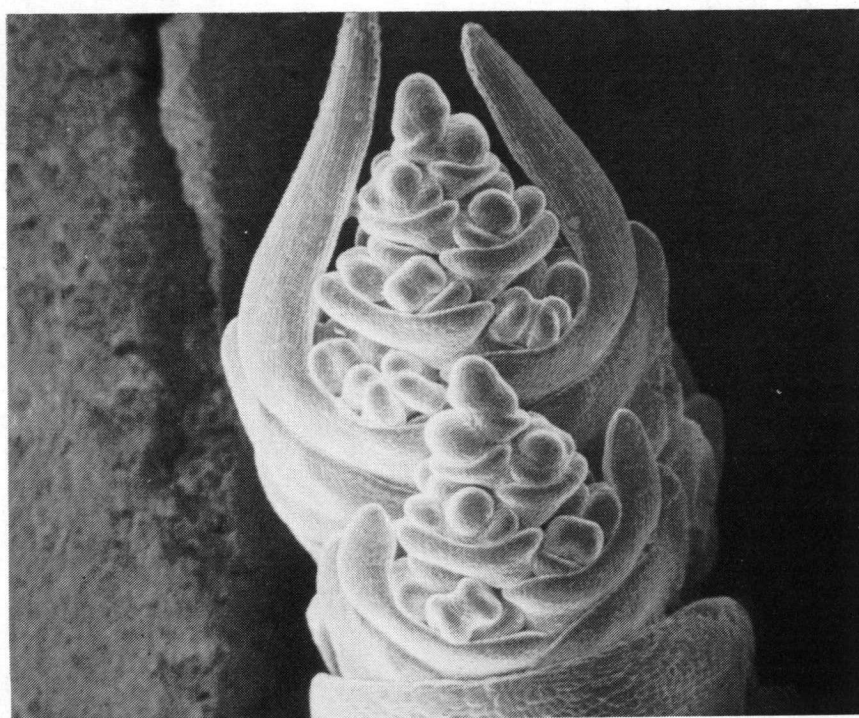


Plate 11: (Above) Dissection and microscopic examination of wheat spikes is routinely conducted by Mr Steve Collett. (Below): A developing spikelet is shown with florets at various stages of development between initiation and early anther development.



the plants to maintain the positive pressure potentials necessary for continued leaf elongation under water stress conditions. Water stress resulted in lower leaf areas, smaller leaves, reduced rates of leaf appearance and a decrease in both leaf and stem growth rates. Stem extension was more severely affected by water stress than leaf elongation and exhibited a lower cumulative growth.

Furthermore, leaf growth when not limited by water deficit was found to be highly responsive to diurnal temperature, with low ambient temperatures at night inhibiting growth.

Citrus trunk water potential

Direct measurements of tree trunk water potentials would be very useful in studies of water movement and gradients of water potential in citrus trees, although the measurements are extremely difficult to make. We have been studying the possibility of using screen-caged thermocouple psychrometers, incorporating certain special procedures for insertion of the psychrometers into the xylem and careful thermal insulation of the trunk. The thermal insulation surrounding the citrus trunk in which the psychrometers have been inserted is shown in Plate 10. Changes in trunk diameter were recorded using a linear variable differential transducer. One of the main problems encountered was to ensure adequate insulation of the psychrometers in the trunk so as to eliminate large temperature gradients which result in unreliable measurements due to large zero offsets. Trunk water potential measurements compared reasonably favourably with estimates of predawn covered ψ_L under the canopy from pressure chamber determinations.

Floret development

Dissection of the wheat spike under the microscope (Plate 11) was conducted to follow the effects of water stress on spike, spikelet and floret development. Floret initiation and development (Plate 11) appeared to be fairly insensitive to early water stress

compared with the onset of the floret degeneration, which was advanced quite markedly with stress. The decrease in yield due to water stress was caused primarily through a decrease in the number of tillers per plant and therefore in spikes per hectare. Parameters indicative of floret degeneration were established in order to determine when florets became non-viable. There is little information in the literature on this subject, and acquired data should therefore be useful to other researchers wishing to assess floret viability.

Root growth and soil water

The need for a better understanding of the concept of plant available water stimulated initial observations on root distributions, refinement of neutron probe calibrations (Plate 12) and a survey of spatial variability of clay content and bulk density of field soil. Root growth patterns of field grown crops usually reflect soil conditions, with soil water frequently being the major cause of differences in root growth. During a number of seasons root growth rates, distribution and depth of penetration have been monitored for wheat, soybeans and potatoes (Plate 13) under a standard overhead sprinkler irrigation system. This has provided an understanding of root growth rates, distribution and depth of penetration throughout the season. Measurements of actual root lengths at different depths in the profile have also been made using the root length scanner (Plate 13). Root growth and water extraction patterns are currently being studied under deep and shallow irrigation applications. The information from these studies, together with simultaneous above-ground measurements of plant water status, is essential in models of plant water use and extraction from the soil.

Movement of water through soil

Soils having a low hydraulic conductivity are not good irrigation soils and are difficult to manage. Knowledge of water movement patterns within the soil profile is essential in crop water use modelling as most soil-water transport

processes such as infiltration, evaporation and uptake by plant roots involve flow in unsaturated soil. The hydraulic conductivity of the soil and its variability with water content is one of the most important parameters affecting these processes and must therefore be accurately assessed in order to describe flow in the soil-plant-atmosphere continuum. Field determinations (Plate 14) although time consuming, are preferable as it is unrealistic to measure hydraulic conductivity in a laboratory where small and discrete samples which have been removed from their natural surroundings are likely to be unrepresentative. The Bower double ring infiltrometer method was chosen as one of the simplest field methods and is now being used with some modification (addition of a surface impeding layer of kaolin and soil) in studies on the spatial and temporal variability of hydraulic conductivity in the field.

Canopy temperature measurements

In recent years considerable interest has been shown in the possibility of using canopy temperatures as indicators of plant water status. Canopy temperatures of water-stressed plants are usually higher than those of non-stressed plants and this has led different researchers to suggest that the temperature difference between a selected reference and the canopy, or the variability of canopy temperature itself is the basis for a stress index. The approach followed at Roodeplaat was to evaluate the usefulness of the infra-red thermometer by assessing the influence of environmental parameters, other than soil water, on the variability of measured canopy temperatures. Also investigated were relationships between canopy temperatures and various physiological parameters in order to evaluate proposed canopy temperature based stress indices for irrigation purposes, with special emphasis on their sensitivity.

A Teletamp infra-red thermometer (Plate 15) was used for monitoring canopy temperatures of four differently irrigated spring

(To page 26)

WATER STRESS

(From page 25)

wheat plots. Incoming radiation, wet and dry bulb temperature, wind speed and net radiation were recorded with the data acquisition system. Leaf water potentials and related plant physiological measurements were also routinely recorded.

Mean canopy temperatures of stressed plots were higher than air temperature and it was thus possible to differentiate between stressed and non-stressed plots. In certain cases the onset of water stress could be detected. Increases in canopy temperature were related to Ψ_L and stomatal diffusive resistance. However, some precautions in interpreting the results are necessary. For example, large canopy temperature changes (2-2,5 C) were observed with sudden wind speed changes, and this seems to preclude the use of spot measurements, especially in the early stages of water stress.

Water use and final yield

In all irrigated systems an important consideration is the relationship between final yield and the amount of water used to achieve the yield. This is studied using "water yield curves" (Fig 3) which show the efficiency of water usage (yield per unit water) remaining constant for low and intermediate yields but decreasing for the highest yield when it becomes dif-

ficult to avoid wasting some water and other factors such as nutrition, genetic potential, etc. may become limiting. These curves and considerations are useful in assessing irrigation efficiency and for predictive and planning purposes.

Irrigation scheduling

In South Africa, as in many other parts of the world, the need for efficient use of limited water supplies is becoming increasingly important. Scheduling of irrigation involves estimating the time of application and the amount of water to apply. A number of different ways of scheduling irrigation are available including the use of evaporation pans and crop factors, tensiometers (Plate 16), and water-balance methods. In all these methods it is necessary to estimate evapotranspiration water losses.

A good first approximation of evapotranspiration can be gained using pan evaporation together with the crop factor. Pan evaporation has the advantage of being readily available. However, any such empirical relationship is of

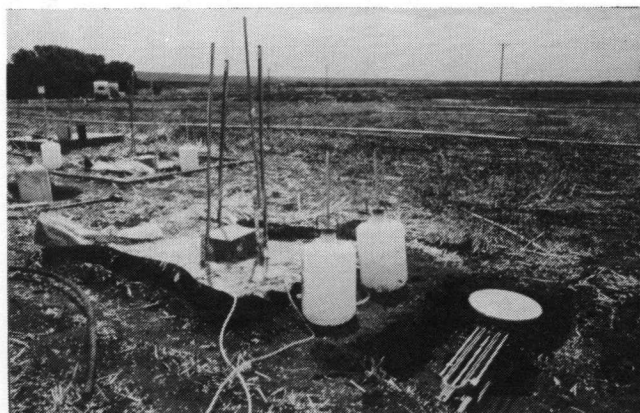
limited value in understanding the interaction between soil, plant and atmosphere. A number of other methods of predicting evapotranspiration have been tried and, at present, the most successful appear to be those which are based on energy balance concepts. The success of these methods can probably be attributed to the fact that they attempt to model the actual system rather than use some artificial approximation.

Work at this and other centres has shown that prediction of



(Left) Plate 12: The neutron probe provides a measurement of soil water content at different depths in the profile. Mr Tony Proffitt has been checking calibration procedures for the neutron meter and is currently investigating root growth and plant available water.

(Below) Plate 13: Potato root development in the field.



(Left) Plate 14: Measurement of soil hydraulic conductivity in the field.



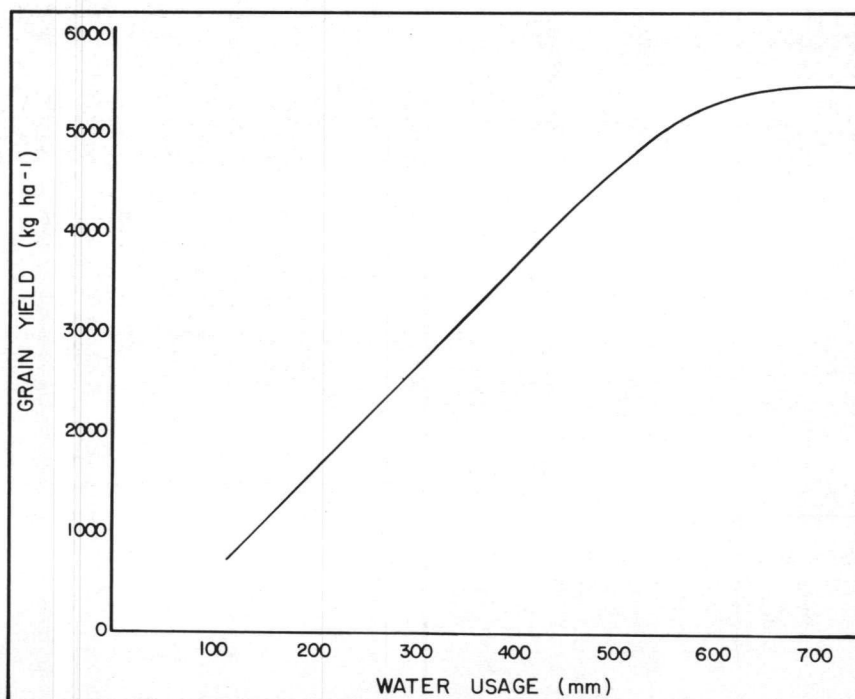
(Right) Plate 15: The infra-red thermometer gives a measure of canopy temperature and is being evaluated in irrigation scheduling studies by Mr Berliner and Dr Oosterhuis.

evapotranspiration from properly calibrated energy balance formulae produces good results and contributes to our understanding of the process of evapotranspiration. Results further indicate that evapotranspiration rates will exceed those predicted by energy balance formulae in summer rainfall areas where irrigated winter and spring crops are surrounded by large non-irrigated areas. The USDA irrigation scheduling model, calibrated for local conditions, has been used for a number of seasons and found to be suitable for irrigation scheduling at Roodeplaat.

Modelling

The information gained from all the above studies is intended to improve our understanding of water movement in the soil-plant-atmosphere continuum in order to be able to simulate and predict water use by plants and hence forecast water use efficiency and crop yield. Modelling is needed to provide links between the various components of the soil-plant-atmosphere system, and to guide the acquisition of field data, and also to form a framework for data processing.

The ultimate challenge in this type of research would obviously be development of a fully deterministic, empiricism free, model of the entire system, enabling the calculation of the water transport from soil to plant to the atmosphere and the related plant responses, under any combination of soil and environmental conditions and for different crops. For the present, however, understanding of the various processes involved is not adequate for this task. Consequently, the task, far too important to set aside in anticipation of more complete understanding, has to date been, and will in the foreseeable future continue to be, most successfully dealt with by models containing significant degrees of empiricism. A wheat growth model developed and provided by Dr Joe Ritchie in Texas has been selected as a working model in which local research findings will be incorporated and with use will also indicate further research needs.



(Above) Fig 3: Water usage and wheat yield for different irrigation treatments.

(Right) Plate 16: Tensiometers located at varying depths in the profile are used to monitor soil water status for irrigation scheduling. Dr Arend Streutker, seen checking the tensiometers, is involved in using the irrigation research findings to improve irrigation management on a farm scale.



Conclusion

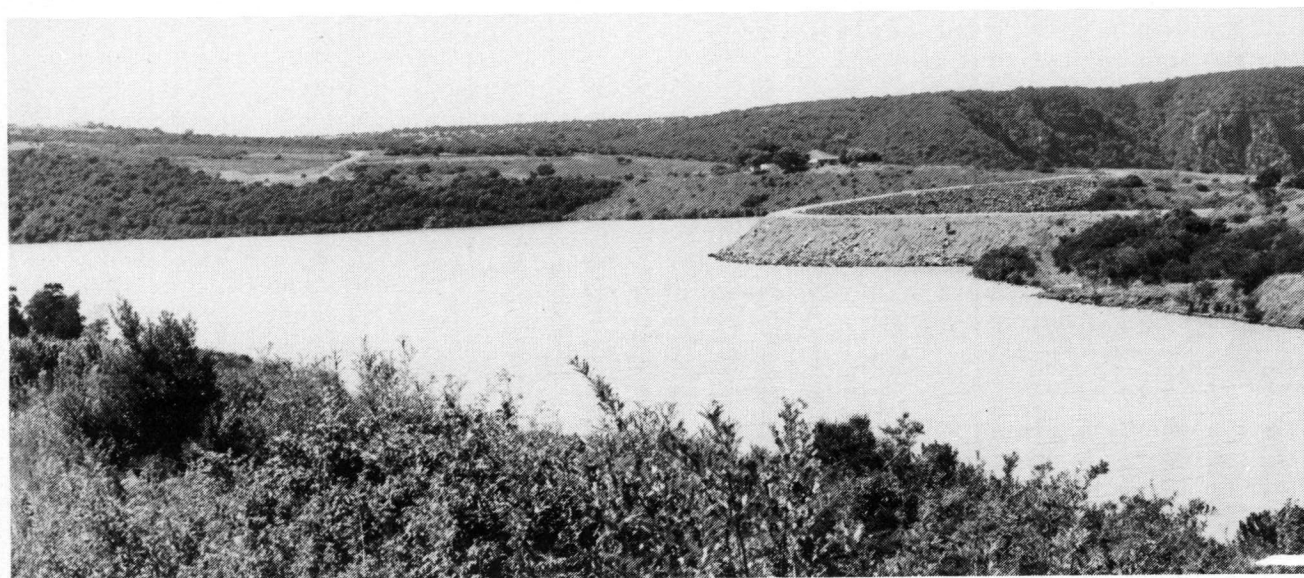
Studies by the Agrohydrology Section of Soil and Irrigation Research Institute have significantly contributed towards a better understanding of various aspects of water movement from soil through the plant to the atmosphere. These aspects include crop water use, response to water stress, indicators of water stress, timing and scheduling of irrigation, evapotranspiration, energy balances above the canopy, root growth and soil water availability. These findings are being incorporated into crop growth models and irrigation scheduling models.

Current research will continue until models for predicting daily water use, based on values of soil water status, crop parameters and meteorological data, are sufficiently refined to enable wider use for management and planning purposes than is currently possible. Also until water stress in crops can be clearly recognised and quantified, and the influence of water stress on yield reduction can be quantified.

Lastly, the results of the intensive research will eventually need to be interpolated and extrapolated to cover a wider range of crops, different climatic regions, and incorporation into practical farming operations.

Water quality:

Report on Buffalo River released



The Bridle Drift Dam in the Buffalo River in the Eastern Cape.

A collaborative report on water quality in the Buffalo River catchment has been released by Rhodes University in Grahamstown. The Department of Geography and its Hydrological Research Unit, the Institute for Freshwater Studies and the Leather Industries Research Institute of the University, and the JLB Smith Institute of Ichthyology have been the contributing organisations.

Financial support for the compilation and preparation of the report was provided by the Inland Waters Ecosystem section of the Cooperative Scientific Programmes, CSIR, for whom the report was prepared, and by Rhodes University, through help in kind.

The overview states that no exploitable mineral resources are known to exist in the Buffalo River catchment. Thus water and vegetation, as limited or as copious as they may be, provide the resource base for human occupancy of this catchment. Probably precisely because of Man's dependence upon them, these resources are most highly at risk in this catchment. They require judicious management and wise exploitation to ensure their long-term usefulness.

The current multi-disciplinary data base upon which objective management and exploitation depends is not adequate. Nevertheless, existing facts allow for the incontestable and inescapable con-

clusion that the water resource base of the Buffalo River catchment is particularly sensitive and vulnerable, both as a result of natural and artificial circumstances. Some of the more important indications of, or pointers to, this sensitivity and vulnerability are:

- The underlying geology imparts a high level of natural mineralization to ground and surface waters.
- Local climatic conditions (high evaporation, and low and often variable rainfall) accentuate the problem of natural mineralization of ground and surface water resources.
- Geological and physiographic characteristics of the catchment favour high sediment production rates, further compounded by the prevailing hydrological regimen. The erosion hazard is correspondingly high over much of the catchment, with concomitant actual or potential degradation of the water resource base (reservoir siltation, loss of the soil base supporting vegetal cover, etc.).
- Water quality is degraded further from a naturally elevated baseline condition as a result of industrial, domestic and agricultural effluents, the relative contributions of which to mineralization and eutrophication are not known. Both diffuse- and point-source contamination is involved.
- The major storage reservoirs are situated downstream of major pollutant sources and catchment modification/degradation activities, which the largest reservoir (Bridle Drift Dam) is threatened by runoff containing a high organic and suspended solids content from extensive and burgeoning high-density urbanization in its proximity. This reservoir provides the drinking water for the bulk of inhabitants of the catchment.
- The joint storage capacity of

existing mainstream reservoirs approximates the average assured net annual yield of the catchment. Thus increased storage capacity for water from the catchment cannot be sensibly contemplated. Serious disparities which exist in Mean Annual Runoff estimates for Bridle Drift Dam complicate holistic planning of the catchment's water resource base.

- Average population density is extremely high (c. 400 per km²) in the catchment, giving rise to high overall water demands. Furthermore, increasing living standards which tend to elevate *per capita* water requirements, are expected to aggravate the situation.
- The number of people in the area is expected to increase, perhaps rapidly, due to Government efforts to stimulate industrial development in the East London area; citizens returning to a newly independent Ciskei; and the prevailing high rate of natural increase amongst the black population. In the longer term, population pressures may increase still further as a result of the predicted eastward encroachment of the Karoo and the immigration into the Buffalo River catchment of inhabitants vacating the increasingly arid areas to the north-west.
- The subsistence economy of many contemporary inhabitants of this catchment forces their reliance upon natural vegetation as a resource for fuel (for heating and cooking) and construction materials (for housing). Increasing population pressures, and any depressions in the economy, are likely to lead to inordinately and unsustainably high demands on the natural vegetation of the catchment. The implications of reduced vegetal cover to the hydrological cycle and the production of sediment have not been quantified for this catchment; but the environmental ramifications of loss of vegetal cover are generally known to be alarming and difficult to control or reverse, especially in arid or semi-arid areas.

- In an attempt to attain self-sufficiency in food production, increasing demands for irrigable lands and water for irrigation purposes can be expected in the catchment. The mineral content of certain waters already pose an irrigation hazard. The potential damage to soil and water quality characteristics following increased irrigation require consideration, especially since most of the catchment area in which irrigation might be contemplated occurs upstream of the principal storage reservoirs.
- The two major storage reservoirs have exhibited almost exponential increases in the plant nutrient content of their waters in the past decade. An inadequate data base precludes confirmation or rejection of this trend in the past 2-3 years, but it is clear that eutrophication poses a continuing and serious threat to the water resources of the catchment.
- The particular socio-political circumstances of the catchment have complicated the assignment or allocation of specific group or institutional responsibility for particular environmental concerns or have at least hampered the implementation of such responsibilities. Acceptance and implementation of responsibility for specific environmental issues is vital to curtail environmental degradation of the catchment. Collaborative efforts between a multiplicity of concerns and interests will be necessary to accommodate decisions upon which the longer-term viability of the catchment depends.

The conclusion states that a holistic long-term management plan for the catchment, based upon socio-economic and related environmental requirements is essential to ensure the capability of this catchment to absorb resiliently the increasing pressures to which it is certain to be subjected. It is vitally important to avoid short-term solutions which have devastating, often irreversible, medium to long-term implications.

RUSSE BESPROEI UIT POOLSEE

Die Sowjetunie wil volgende jaar aan die werk spring met 'n plan om varswater uit die Poolsee via 'n aantal riviere, kanale en mere na droë dele in die Europese en Asiatiese gebiede van Rusland te laat vloei.

Hierdie eerste fase, naamlik die afleiding van drie noordelike sytakke van die Wolgarivier sal na raming aan die einde van die tagtigerjare voltooi wees. Deskundiges meen dit kan die Russiese graanoes laat verdubbel. President Bresjnev het onlangs sy toestemming gegee vir die plan wat een van die grootste besproeiingsprojekte in die geskiedenis sal wees.

AKSIE TEEN BESOEDILING VAN MAASRIVIER

Organisasies wat betrokke is by omgewingsbewaring gaan binnekort met 'n plan van aksie begin teen die toenemende besoedeling van die Maasrivier in Europa. Hulle optrede sal veral daarop gemik wees om die radio-aktiewe besmetting van die Maasrivier se water deur kernkragsentrales in Frankryk en België stop te sit.

Die Nederlandse, Vlaamse en Waalse aksiegroepe is ook sterk gekant teen Frankryk se voorgename plan om nog ses kernkragsentrales langs die Maas te bou. Hulle word hierin ondersteun deur die Nederlandse Departement van Volksgesondheid en Omgewingshigiëne, asook deur die drinkwaterbedrywe in Nederland en België.

Die "speurskip" van die stigting *Reinwasser* wat 'n jaar of wat gelede gebou is om besoedelaars van die Rynrivier vas te trap, vaar binnekort van Rotterdam na die Franse dorpie Chooz, waar 'n kernkragsentrale staan. Onderweg sal lede van die aksiegroepe monsters van die Maasrivier se water neem en in die laboratorium wat spesiaal vir die doel op die skip ingerig is, analiseer. Só hoop hulle om vas te stel wie wat waar stort.

Dr Hattingh by WNK



Dr WHJ Hattingh, voorheen direkteur van die Hidrologiese Navorsingsinstituut te Roodeplaatdam, is aangestel as senior adviseur van die Waternavorsingskommissie en sal in die besonder met die gesondheidsaspekte van waterherwinning gemoeid wees.

Dr Hattingh is in Johannesburg gebore en ontvang sy skoolopleiding aan die Hoërskool Helpmekaar. Na voltooiing van sy graad in Chemie en Fisika aan die Potchefstroomse Universiteit aanvaar hy 'n pos as analitiese skeikundige by die Daggafonteinmyn te Springs. 'n Jaar later word hy na die navorsingslaboratorium van die Kamer van Mynwese verplaas — die aanvang van sy loopbaan op die gebied van die wateromgewing.

In 1957 word dr Hattingh weer student en verwerf die honneursgraad in Chemie aan die Universiteit van die Witwatersrand. Hier na sluit hy by die Nasionale Instituut vir Waternavorsing van die WNNR aan. In 1960 behaal hy die graad M Sc in Chemie aan UNISA en vertrek na Kanada waar hy in 1962 die graad Ph D in die Mikrobiologie verwerf.

Meer as vyftig publikasies oor verskillende aspekte van waterkwaliteit het reeds uit sy pen verskyn.

Forthcoming books

POLDERS OF THE WORLD

PAPERS INTERNATIONAL SYMPOSIUM POLDERS OF THE WORLD

October 1982, Lelystad, The Netherlands

Volume I 719 pp.

Volume II 739 pp.

Paperback — illustrated with 48 photos and many drawings.

ISBN 90 70260 75 1

90 70260 76 X

The wealth of papers received by the symposium secretariat necessitated to bundle them in two volumes for use during the symposium.

The papers have been arranged

in accordance with the main subject being polder projects and the fields related to these projects, such as:

land and water management, construction, agriculture, socio-economy, environmental aspects.

The books cover some 130 papers; besides the table of contents, an author index is given for quick reference.

This publication is available from the International Institute For Land Reclamation And Improvement (ILRI), P.O.B. 45, 6700 AA Wageningen, The Netherlands.

BOOK REVIEW

BULKING OF SLUDGE

Bulking of Activated Sludge: Preventative and Remedial Methods by B Chambers and E J Tomlinson (Published by ELLIS HORWOOD LIMITED, Chichester, UK).

This book is derived from the Water Research Centre conference entitled "Bulking of Activated Sludges: Prevention or Cure" held in Cambridge in April 1981.

The papers presented at this conference are set out in chapter form in the book. Posters displayed at the conference are included as an Appendix. The book also includes the discussions on the papers.

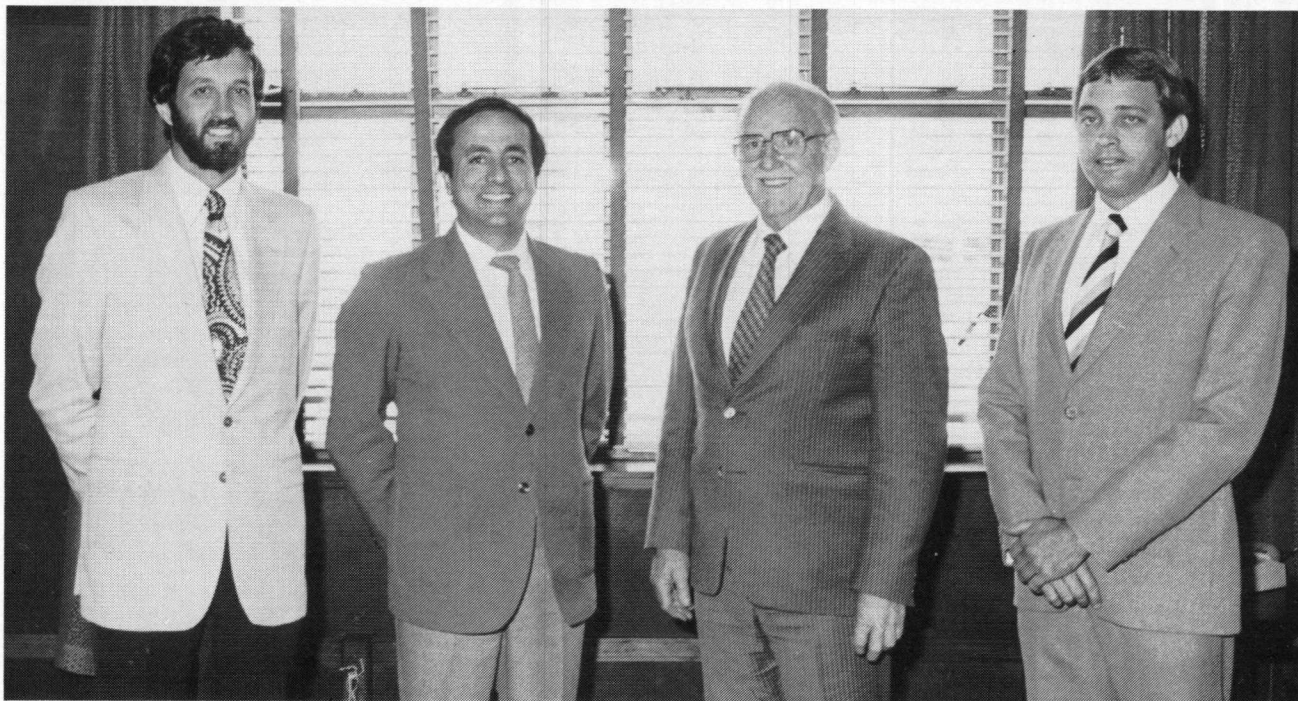
The book is divided into four parts. PART 1: THE PROBLEM offers historical background to the problem of sludge bulking as well as statements on the current situation. PART 2: MICROBIOLOGICAL ASPECTS — THE STATE OF THE ART comprises contributions on the applications of Eikelboom's identification key for filamentous organisms in activated sludge, the development of a technique to predict bulking and a paper on the physiology of *Microthrix parvicella*. PART 3: PROGRESS THROUGH LABORATORY AND PILOT SCALE STUDIES deals with studies related to the mechanism of sludge bulking and factors con-

trolling it. PART 4: CONTROL STRATEGIES outlines a variety of techniques for the control of sludge bulking which have been successfully applied at full scale.

The contributors to the book are all acknowledged experts in the field of sludge bulking. Each has produced a definitive statement which points the way to more confident design and operation of activated sludge systems. Many of the contributors presented the results of original research, making this book a valuable collection of new information. The inclusion of the discussions on each contribution is most useful since it gives the reader an immediate critical assessment of these contributions by the foremost specialists in this field. The last part of the book on control strategies should be of great value to process engineers and plant operators in the wastewater industry.

The literature on sludge bulking to date has often been confusing and contradictory, particularly for those in practice who wish to design and operate activated sludge plants with minimal sludge bulking problems. This book establishes a firm and authoritative basis and reaches some common ground in the solution of the problem of poor activated sludge settleability.

EMINENT DUTCH HYDROLOGIST VISITS SA



Dr E Seyhan, an eminent hydrologist from the Netherlands whose special field of research is the application of multivariate techniques to small catchments hydrology, recently visited the Republic. Pictured in the usual order are Mr D Cousins, adviser at the Water Research Commission, Dr Seyhan, Dr MR Henzen, chairman of the WRC, and Mr AS Hope from the Department of Geography, University of Zululand.

IBW-KONGRES in OOS-LONDEN

Die volgende twee-jaarlikse konferensie en uitstalling van die Instituut vir die Bestryding van Waterbesoedeling (SA Tak) sal volgende jaar, van 16 - 19 Mei 1983, in Oos-Londen plaasvind.

Program

Die program bestaan uit drie dae van tegniese aanbiedings, 'n uitstalling en 'n na-konferensie tegniese toer van die Buffelsrivier-opvanggebied. 'n Volledige program sal in die volgende uitgawe van SA Waterbulletin verskyn.

CALL FOR PAPERS

The 10th International Symposium on Urban Hydrology, Hydraulics and Sediment Control will be held at the University of Kentucky, Lexington, KY. on July 25-28, 1983. Authors are invited to submit 250-500 word abstracts on the following subjects: 1) urban storm-water runoff and sediment control, 2) water distribution systems, 3) hydraulics of urban drainage systems, 4) quantifying rainfall, runoff, sediment production and nonpoint water quality (including acid rain), and 5) related topics. Papers reporting research results, design and analysis techniques, legal aspects and case studies are encouraged. In addition, abstracts of mini-course sessions (approx. duration 4 hours) on appropriate subjects related to the Symposium are also encouraged.

Abstracts should be submitted by December 31, 1982, to Liz Haden, Coordinator, Office of Continuing Education/Engineer, 223 Transportation Research Building, University of Kentucky, Lexington, KY 40506-0043. For further information call 606/257-3972.

FRANSE DRINK SWAK WATER, SÊ MINISTER

Amper dertig miljoen Franse, meer as die helfte van die bevolking, se water wat by hulle krane uitkom en wat hulle drink voldoen nie aan die normale graad van suiwereheid nie. In baie gevalle bevat dit siektekieme en stowwe wat skadelik is vir die menslike gesondheid.

Ongeveer vier miljoen Franse drink selfs water wat soveel salpeter, afkomstig van kunsmis, bevat dat dit vir swanger vroue en babas tot op ses maande gevaarlik is. Dié feite is onlangs in Parys deur die Franse Minister van Gesondheidsake, mnr Jack Ralite, bekendgemaak.

Oorsake

Die belangrikste oorsake van die swak gehalte is die minderwaardige toestand van die pype in waternetwerke, asook die feit dat daar in baie dorpe nog geen riolerings bestaan nie. Voorts lei die toenemende gebruik van kunsmis al hoe meer tot 'n hoë konsentrasie kaliumnitraat in die water.

OPLOSSING VIR FOSFATE

Hoechst Holland, 'n filiaal van die Hoechstmaatskappy in Duitsland, is sterk gekant teen die Nederlandse regering se planne om alle gebruik van fosfate in wasmiddels teen 1985 heeltemal in Nederland te verbied. Die hoofbestuurder van die maatskappy, mnr D J Brand, het met die vrystelling van Hoechst Holland se jaarverslag gesê dat die landswye fosfaatverbod die probleem van oormatige algegroei in sommige gebiede glad nie sal oplos nie. "Slegs die aanbring van 'n ekstra derde stap in bestaande afvalwatersuiweringsinstallasies – iets wat ons al jare lank bepleit – kan 'n te hoë fosfaat-konsentrasie afdoende bestry," het hy gesê.

Oormatige algegroei ontstaan deur 'n hoë konsentrasie voedingstowwe (veral fosfate) in die oppervlaktewater. Deur die algegroei "versmoor" die water en kry 'n groen kleur.

Volgens mnr Brand bestaan daar 'n oplossing vir die twee nadele wat verbonde is aan die ekstra suiwering van die water, naamlik slyk en koste. Hy het verwys na 'n stelsel wat deur 'n groep raadgewende ingenieurs in samewerking met die Ryksinstituut vir die suiwering van afvalwater ontwikkel is. Volgens dié stelsel word die fosfate in die afvalwater met behulp van 'n fluïedbed en deur die toevoeging van natronloog aan kalsium verbind. Die balletjies wat sodoende gevorm word, sal weer in die kunsmisbedryf of in fosforoende gebruik kan word. Só ontstaan geen ekstra slyk nie. Met die opbrengs van die verkoop van die korrels kan 'n deel van die suiweringskoste gefinansier word, en word die kostebeswaar uit die weg geruim.

Mnr Brand het voorts daarop gewys dat die ontwikkeling van alternatiewe stowwe vir fosfate in wasmiddels baie geld kos. Dan is daar ook nog kostes in die vorm van slytasie van wasgoed en die korter lewensduur van wasmasjiene wat geld uit die publiek se sak gaan jaag.

BEVORDER



Mnr Eberhard Braune is aangestel as die nuwe direkteur van die Departement van Waterwese se Hidrologiese Navorsingsinstituut naby Pretoria. Hy volg dr WHJ Hattigh op wat onlangs 'n pos as senior adviseur by die Waternavorsingskommissie aanvaar het.

Mnr Braune wat in Schwerin, Oos-Duitsland, gebore is, het in 1951 na Suidwes-Afrika geïmmigreer. Hy begin sy loopbaan in 1963 by die Nasionale Instituut vir Waternavorsing van die WNNR as 'n chemikus in die hidrobiologiese afdeling en werk veral op die gebied van die chemie van rioolwater en die besoedeling van mere en riviere. Vanaf 1965 tot 1974 is hy verbonde aan die Departement van Waterwese in Windhoek, SWA, waar hy uiteindelik bevorderd word tot hoof van die hidrologiese afdeling.

Gedurende 1967 en 1970 studeer hy aan die Institut für Siedlungswasserbau und Wassergütewirtschaft in Stuttgart, Duitsland, en die Imperial College in London, onderskeidelik, en in 1971 word 'n meestersgraad in hidrologiese ingenieurswese deur die Imperial College aan hom toegeken.

In 1978 word mnr Braune aangestel as assistent-hoof van die Departement van Waterwese se hidrologiese afdeling in Pretoria – 'n betrekking wat hy tot met sy huidige bevordering beklee het.

Mnr Braune is getroud en die egpaar het drie kinders.

ENERGY SAVINGS AND CONTROL OF WATER POLLUTION

The International Association on Water Pollution Research and Control and the European Water Pollution Control Association will present a specialised conference entitled 'Energy savings in water pollution control' in Paris, France, from September 26 to 28, 1982.

The purpose of this conference is to sum up the reflections, the researches and the work on energy savings in water pollution control.

Technical Topics:

- Effect of pollutant concentrations, removal rates, load variations, overdimensioning, upon energy consumption.
- Direct or "Induced" energy savings (including investment and operation expenses).
- Mathematical models which may help to assess energy expenses.
- Comparison of energy expenses in various conventional biological processes (effect of influent distribution modes, of number of treatment lines).
- Energy expenses in alternative processes (physicochemical, anaerobic, film fixed reactors).
- Interest of automation.
- Energy recovery in digestion and incineration plants.
- Power plants fed with digestion gas (gas engines, gas turbines, blowers directly driven with gas engines, electrical energy production).
- Thermal drying and energy expenses.
- New technologies leading to energy savings for water oxygenation means, sludge treatment, heating systems, pumping means, etc...).
- Soft technologies (lagooning, etc...).

For more information write to:

"ENERGY SAVINGS IN WATER POLLUTION CONTROL"
A.G.H.T.M. (M. BRES)
9 Rue de Phalsbourg
75854 PARIS CEDEX 17
FRANCE

VERSLAG OOR EUTROFIKASIE GEPUBLISEER

'n Verslag oor eutrofikasie is onlangs deur die Organisasie vir Ekonomiese Samewerking en Ontwikkeling (OESO) in Europa gepubliseer. Die verslag gee 'n oorsig van tien jaar se navorsing wat deur OESO-deskundiges gedoen is. Die kompleksiteit van eutrofikasie word beskryf en faktore wat tot die ontwikkeling van die verskynsel lei. Riglyne vir die mees doeltreffende metodes om eutrofikasie te beheer, word ook aan die hand gedoen.

Die OESO-navorsing was veral daarop gemik om die verhouding tussen die voedingslading in die water en die trofiese reaksie daarvan te bepaal. Agtien lidlande en 'n groot aantal institute en navorsers het op 'n vrywillige basis aan die projek meegewerk en daar is deurgaans van die jongste beskikbare inligting gebruik gemaak.

Die navorsingsprogram is uitgevoer deur die projek te verdeel in vier hoofstreeksprojekte wat 'n wye verskeidenheid geografiese en limnologiese situasies gedek het (Alpynse, Noordiese, Reservoir en vlak mere en die Noord-Amerikaanse projek.)

Volgens die verslag kan die resultate wat behaal is prakties toegepas word om eutrofikasie te beheer, maar is daar aanbevelings dat die resultate versigtig gehanteer moet word en dit nie geskik is vir gevalle wat buite die bestek van die navorsingsgebied val of situasies wat van dié in die program verskil nie.

Die belangrikste beheerstrategie is 'n vermindering in die eksterne vrag voedingsstowwe. In gevalle waar so 'n vermindering tot die vereiste toleransievlak onprakties of onmoontlik is, moet ander beheermaatreëls, en nie nutriëntvermindering nie, toegepas word. Sulke alternatiewe beheermaatreëls kan egter slegs bepaal word deur gebruik te maak van georderde modelleringsstegnieke, aldus die verslag.



First Announcement and Call for Papers

Third International Conference on Urban Storm Drainage June 4-8, 1984

Chalmers University of Technology, Göteborg, Sweden

The objective of the conference is to present, discuss and summarize current developments and experience in the field of urban storm drainage.

Papers are invited within the entire field of urban storm drainage, especially papers dealing with:

Stormwater problems in combined sewer systems

Overflows and detention basins. Quantitative and qualitative aspects. Infiltration/inflow problems. Real time simulations.

Pollutant loads in urban water systems

Sources and transport of pollutants. Effects on receiving waters.

Optimization of urban drainage systems

Risk analysis and optimization techniques in the design and management planning.

Storm sewer hydraulics

Mathematical modelling of surcharged systems. Instability problems. Energy losses. Field and laboratory investigations.

Input data for mathematical models

Selection of rainfall data, catchment data and other input data.

Administration of mathematical models

Management and updating of models. Availability of models and manuals. Selection of models.

Data collection and evaluation

Rainfall and runoff, quantity and quality. Experience from monitoring of research catchments.

Stormwater infiltration

Infiltration of stormwater on permeable surfaces and in basins. Quantitative and qualitative aspects.

Snowmelt problems in urban hydrology:

Intensity. Infiltration and runoff. Quantitative and qualitative aspects.

Information

For further information, please contact:

Per-Arne Malmqvist, conference secretary, Third International Conference on Urban Storm Drainage, Chalmers University of Technology S-412 96 Göteborg, Sweden.

HARDE WATER NIE BETER VIR HART

Harde drinkwater is nie beter vir 'n mens se hart en bloedvate as sagte water nie. Dit is die gevolgtrekking van 'n Nederlandse studiegroep wat die gevolge van waterversagting op die volk se gesondheid ondersoek het. Die studiegroep het die Nederlandse Minister van Volksgeondheid in kennis gestel dat daar geen besware meer bestaan teen 'n algemene vermindering van waterhardheid nie.

Waterversagting sal ook die Nederlanders help in hulle stryd teen fosfate in wasmiddels aangesien minder wasmiddel by sagte water as by harde water gevoeg hoef te word.

Third International Symposium on Anaerobic Digestion

14-20 August 1983
Boston, Massachusetts, USA

ANAEROBIC DIGESTION

The science and technology of anaerobic digestion have grown vigorously in the last decade. The behaviour of anaerobic microbial populations is receiving intense study. Applications to waste disposal, energy generation and chemical production continue to grow. This interest in and appreciation of the benefits of anaerobic digestion is worldwide. A specialized forum now exists for exchange of information about anaerobic digestion.

THE INTERNATIONAL SYMPOSIUM ON ANAEROBIC DIGESTION

The First International Symposium was held at Cardiff, Wales, in 1979. The success of the Cardiff meeting and of the Second Symposium at Travemünde, Germany, in 1981, led to the establishment of a regular symposium series.

THE PROGRAM

The Symposium will consist of lectures, poster sessions, and discussion periods. The technical content will include:

- Microbiology
- Biochemistry
- Fermentation Kinetics
- Pollution Control
- Methane Generation
- Solid Waste Treatment
- Liquid Waste Treatment
- Biomass Utilization
- Appropriate Feedstocks
- Regional Applications
- Thermophilic Operation
- Production of Chemicals
- Landfill Operation
- Agricultural Applications
- Process Design
- Engineering
- Process Economics
- Process Control
- Analysis of Performance
- Assessment of Prospects

TECHNICAL SESSIONS

At plenary sessions, lectures will be presented by workers active in the many areas of anaerobic diges-

tion. The lectures will constitute a coherent view of anaerobic digestion with many details of matters ranging from the fundamental to the applied.

POSTER SESSIONS

In order to accommodate the volume of useful information in this active field, extensive poster sessions will be presented. The scope and specific content of the poster presentations will be incorporated into the plenary sessions by rapporteurs. Authors wishing to present poster sessions are requested to inform the Symposium Chairman of their intent and to plan submission of an abstract by 1 November 1982.

ADDRESS FOR INFORMATION:

Third International Symposium on Anaerobic Digestion
89 Erie Street, Cambridge, MA 02139 USA

Vatikan wil gratis water hê

Volgens die munisipaliteit van Rome se waterafdeling betaal die Vatikanstad 'n geruime tyd nie meer hulle waterrekening nie. Die agterstallige bedrag het nou al gegroei tot meer as R2,5 miljoen.

Op die oomblik is onderhandelings oor die saak aan die gang. Die Vatikan is egter nie baie tegemoetkomend nie aangesien hulle meen hulle kan hulle beroep op 'n ou ooreenkoms met die stad Rome waarvolgens water gratis sou wees – net soos wat die son op regverdige en onregverdige skyn.

'n Woordvoerder van die waterafdeling het erken dat die Vatikan lank nie die enigste swartskap op hulle lys is nie. Die Departement van Binnelandse sake, die Universiteit van Rome en die brandweer is almal traag om te betaal. En in die laaste geval kan die munisipaliteit beswaarlik die verbruiker se water afsny.

SOCIETY FOR FISH FRIENDS LAUNCHED

A Society of Friends of the JLB Smith Institute of Ichthyology, called ICHTHOS, has been formed to provide an informal channel of communication between people interested in fishes.

The Society was launched recently in Grahamstown and already has an enthusiastic membership of anglers, naturalists, ichthyologists, divers, aquarists, fish farmers and commercial fishermen. The benefits of membership include a free subscription to a newsletter giving interesting facts and figures on fish research, fishing, diving, aquarium keeping, fish farming, commercial fishing and marketing, etc, as well as discounts on books on fishes, published by, or sold in, the JLB Smith Institute of Ichthyology.

Members will be able to purchase items of interest such as wall charts of marine and fresh water fishes and reproductions of colour paintings of fishes as well as T-shirts, sport caps and badges bearing the ICHTHOS logo.

More information may be had from the Hon Secretary, Ichthos, Private Bag X1015, Grahamstown 6140.

GROOT ONTSOUTER OP MALTA

Daar sal binnekort op die eiland Malta begin word met die bou van die wêreld se grootste hiperfiltrasie-aanleg vir die ontsouting van seewater. Die aanleg, wat by Ghar-Lapsi aan die suidekant van die eiland opgerig word sal 'n kapasiteit van 20 000 m³ per dag hê.

Met die hiperfiltrasie-aanleg word die hoeveelheid opgeloste soute in die water van 39 200 mg/l tot minder as 500 mg/l verlaag. Dit beteken dat die water aan die standaard wat deur die Wêreldgesondheidsorganisasie bepaal is, sal beantwoord.

'n Tweede aanleg met 'n kapasiteit van 4 500 m³ per dag word beplan in die omgewing van die hoofstad Valetta in Noord-Malta.

WATERHIASINTE BEVEG BESOEDELING

Die blaadjie R & D berig dat navorsers by die Akron Universiteit in Amerika vasgestel het dat die bekende onkruid die waterhiasint swaarmetale en fenols uit water verwyder. Wat meer is die plant omskep fenols tot 'n nie-toksiese vorm en bewaar dit dan hoofsaaklik in sy wortels. Wanner die hiasint geoes, fyngemaal en gefermenteer word, kan die swaarmetale uitgehaal word terwyl die fenol in metaan omgeskakel en as brandstof gebruik kan word.

Navorsers sê die plant absorbeer al hoe groter hoeveelhede besoedelstowwe sonder om dit weer in die water vry te stel. Aangesien die hiasint slegs in 'n warm klimaat groei, stel wetenskaplikes voor dat die plant gedurende die kouer maande in kweekhuise gebruik word. Die metaangas wat deur die hiasinte geproduseer word, kan ook in die kweekhuis se energiebehoefte voorsien.

Meer inligting is beskikbaar by David O' Keefe of James Hardy, Akron Universiteit, 302 E. Buchtel Av., Akron, OH 44325.

PROGRAMME ON HEALTH SERVICES

The First International Summer Programme on Health Services Evaluation will be held from June 20 to July 8, 1983 in Amsterdam. The title is 'The evaluation of drinking water and sanitation projects'.

The Programme is open to medical doctors, scientists and engineers with at least four years' experience in environmental health programmes regarding drinking water supply, sanitation and similar subjects.

Further information can be obtained from:

Dr. J.M.V. Oomen,
1983 Programme Director
International
Summer Programme on
Health Services Evaluation
The Royal Tropical Institute
Mauritskade 63
1092 AD Amsterdam,
The Netherlands.

"Waterpiek" na Dallas

Die Rotterdamse drinkwaterbedryf (DWL) het op 'n heel oorspronklike wyse tot die gevolgtrekking gekom dat die Nederlanders ook in die greep van die Amerikaanse televisiereeks Dallas verkeer. DWL het naamlik bekend gemaak dat baie min water verbruik word wanneer die televisieprogram Dinsdag-aande in Nederland aan die gang is.

Die teenoorgestelde is egter waar as die Ewings weer van die kassie verdwyn het. Dorstige kele slaan dan toe vir 'n bietjie lafenis terwyl toilette skielik moet oortyd werk. Die gevolg is 'n ongewone piek in die waterverbruik, aldus die Hollanders.

WATERRAMP IN BRASILIË

In die suide van Brasilië is die drinkwater van nagenoeg 400 000 mense deur 'n ongeluk in gevaar gestel. Die ongeluk word deur plaaslike owerhede beskryf "as moontlik die ergste omgewingsramp in die Brasiliaanse geskiedenis."

Swaarmetale soos kadmium, lood en sink het per ongeluk in 'n sytak van die belangrike Paraibarivier beland. Die Paraiba loop langs die grens van die provinsies Rio en Minas Gerais. Volgens 'n woordvoerder van die metaalfabriek Pairabuna het die metale in die rivier beland toe 'n opslagplek vol giftige chemiese afval gebars het.

Die slyk wat stadig in die rivier afgesak het, het die drinkwater van tien stede met 'n inwonersal van nagenoeg 400 000 mense besmet. Duisende visse het gevrek en oral op die oevers het dooie diere gelê wat van die water gedrink het.

Waternetwerke wat met die rivier verbind is, is deur die plaaslike owerheid afgesluit. Inwoners van meer afgeleë dele is gewaarsku om die water selfs nie eers vir die was van klere te gebruik nie. Drinkwatervoorrade in die gebied raak egter vinnig uitgeput.

SODAWATER ONDERSOEK

Die Europese Kommissie het aangekondig dat ondersoek ingestel gaan word na die suiwerheid van mineraalwater. Dié verklaring volg op 'n vraag in die Europese parlement na aanleiding van die Baden-Württemberg voedselinspektoraat se bevindinge in Wes-Duitsland dat een uit elke sewe bottels sodawater chemies of bakteriologies besoedel en ongeskik vir menslike gebruik onder die bestaande wetgewing is.

Waterwoekeraar

Die aanhoudende droogte in die suide van Italië het tot 'n besondere soort misdaad aanleiding gegee: waterdiefstal. Die polisie op Sicilië hou die 27-jarige Carmelo Romano aan wat onwettig die gerantsoeneerde dorpswater getap en dan ten duurste in afgeleë dorpieë wat na water smag, verkoop het.

Tentoonstelling

Die Verenigde State van Amerika het 149 lande genooi om aan 'n internasionale tentoonstelling getiteld *The world of rivers — fresh water as a source of life* deel te neem. Die tentoonstelling wat van 12 Mei tot 11 November 1984 in New Orleans aan die Mississippi-rivier sal plaasvind, handel oor die belangrikheid van varswater vir die voortbestaan van lewe op die aarde.

COLESHILL CLOSING DOWN

The well-known Coleshill experimental Site of the UK's Water Research Centre will close down in April 1983. The programme has been receiving support from the Department of the Environment and the water industry but it was decided that research could be carried out more efficiently at the Stevenage Process Engineering Laboratory.

TOERUSTING

Ten einde 'n inligtingsdiens aan ons lesers te lewer, verwelkom die redakteur bydraes vir publikasie (beperk tot ongeveer 300 woorde en een of twee foto's en diagramme) deur vervaardigers en verspreiders van nuwe toerusting en prosesse wat met die bevordering van water-aangeleenthede verband hou.

Sulke bydraes word egter ontvang of gepubliseer met dien verstande dat: (1) die betrokke vervaardiger of verspreider wat die bydrae lewer, verantwoordelik bly vir die inligting of menings daarin vervat en vir aansprake ten opsigte van daardie toerusting en prosesse; en (2) publikasie daarvan nie impliseer dat die redakteur of die uitgewer of die Waternavorsingskommissie die inhoud van so 'n bydrae aanbeveel of daarmee in ooreenstemming is nie.

Lesers wat meer inligting verlang, word versoek om direk met die vervaardigers of verspreiders in verbinding te tree.

Anton Prinsloo
REDAKTEUR



SA Waterbulletin
PO Box/Posbus 824
Pretoria 0001

EQUIPMENT

As an information service to our readers, the editor welcomes for publication contributions (limited to approximately 300 words and one or two photographs and diagrams) by manufacturers and distributors of new equipment and processes related to the promotion of water affairs.

Any such contribution is, however, received or published on the understanding that: (1) the relevant manufacturer or distributor submitting the contribution is responsible for the information or opinions expressed in it and the claims made therein for that equipment or those processes; and (2) its publication does not imply that the editor or publisher or the Water Research Commission underwrites or is in agreement with the contents of such contribution.

Readers who require further information are requested to contact the manufacturer or distributor direct.

Anton Prinsloo
EDITOR

Pumps:

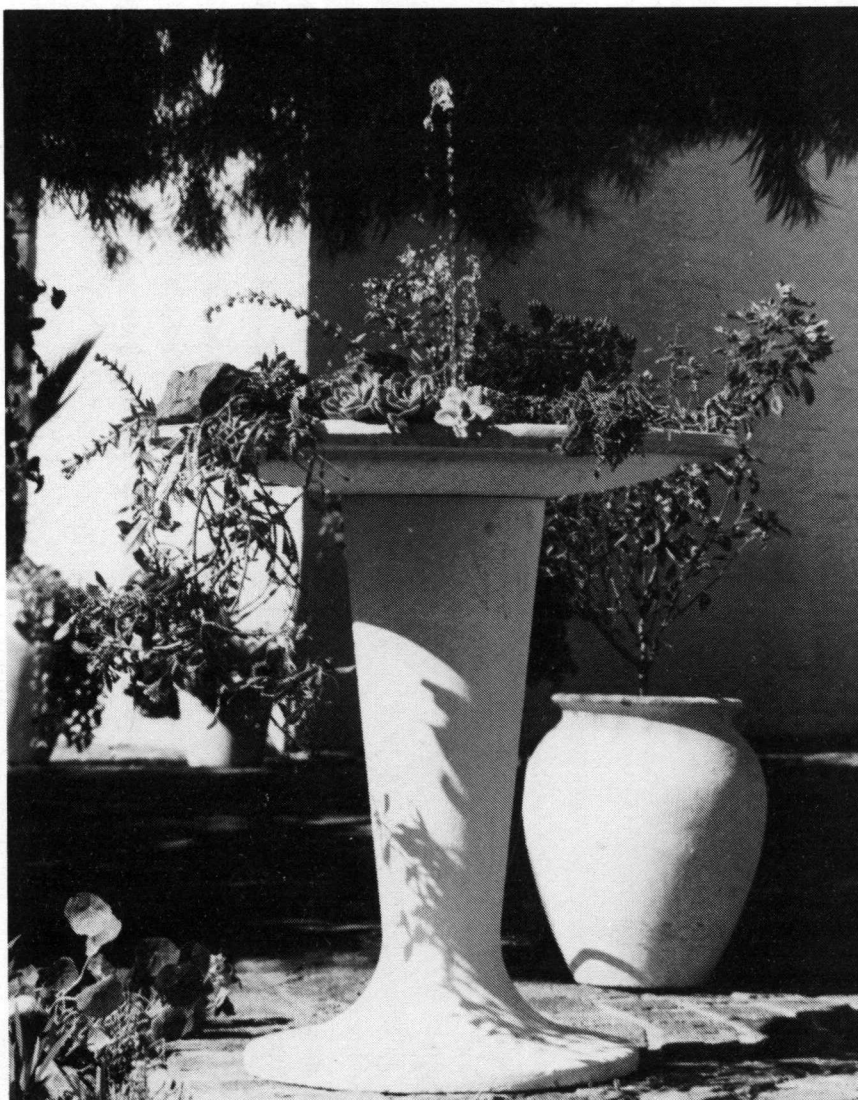
Series of semihouse pumps

Hugh Mellor of Edenvale are perhaps better known as market leaders in the submersible pump business, particularly in the mining sector, but they have now launched a series of semi-domestic pumping products, including a neat little unit known as the FV-JET. This is a combined pump, motor, and mini-fountain-jet, sufficiently compact, and small enough to sit in a shallow bowl, in about 8 – 10 cm of water.

Pleasant

The FV-JET comes complete with 2 m of cable, and is ready to plug into a standard 220 V mains supply. A regulating valve is fitted, to adjust the fountain head, and both noise level, and power consumption are low (35 W). With a few well chosen rocks, and plants, this could be a pleasant feature in either the garden, or indoors in office and hotel reception areas, hallways etc.

Enquiries:
Hugh Mellor & Co Ltd
PO Box 700
Edenvale 1610



EQUIPMENT

Drinking water tablets:

WATER CLARIFIED AND DISINFECTED WITHIN MINUTES

The Chlor-Floc water maker tablet has a unique coagulant—flocculant disinfectant composition that can clarify and disinfect batches of water ranging from 1 to 200 litres within minutes. Because of a simplistic dosing procedure and the non-requirement of any equipment the tablets can supply potable water to all persons distant from water treatment facilities.

Authoritative laboratory tests have confirmed that the tablets yield a water of high bacteriological quality within six minutes, even when applied to unnaturally heavily contaminated waters.

The tablets originated from the need to prepare potable water for the individual and small groups of people under field conditions, i.e. where water is drawn from polluted streams, wells etc.

With the increasing incidence of water-borne diseases and the inadequacy of chemical disinfectants when applied to turbid waters the availability of an agent which rapidly clarifies and disinfects water, is simple to use and is effective in all naturally polluted waters has become essential. Chlor-Floc fulfils these requirements as the tablets can be successfully used even by underdeveloped people, have been found to be effective in hard and soft waters (tested in South Africa, Australia and the U.S.A.), are rapid acting and economical to use. All components in the tablets are approved for the preparation of potable water.

A feature of the flocculation process is

that a large cohesive floc is formed which settles rapidly and the clarified water can thus be filtered through any available filtering material e.g. calico; and because of the cohesive nature of the settled floc the latter is not readily resuspended.

Tablets are available for the treatment of 1 to 200 litres of water; e.g. 20l of water can be drawn from a polluted source, a 10g tablet added and the water stirred until the tablet has dissolved (± 1 minute), when the water returns to the quiescent state after the initial stirring the water is again stirred ± 10 seconds, whereafter the flocculated impurities rapidly settle out. The water can then be poured through any available filtering material, e.g. a maize meal bag. Thus within 10 minutes 20l of clarified and disinfected water can be prepared.

THE EFFICACY OF THE CHLOR-FLOC WATERMAKER TABLET IS DUE TO THE FOLLOWING:

1. The water is clarified.
2. The final solution of clarified water has a pH of approximately 6; HOCl thus predominates.
3. The total residual chlorine attained is approximately 5mg/l.
4. Organic matter is rapidly removed from solution leaving a clarified water containing HOCl. The chlorine releasing compound Halazone ensures that a HOCl residual persists in the clarified water.

5. During the clarification of water by flocculation one of the most important benefits of flocculation is often overlooked, i.e. the removal of the bulk of viruses, bacteria and protozoa from the water by physical entrapment in the flocculated sludge.

Surveys of users of water purification tablets have indicated that the greatest objection to these agents is the bad taste imparted to water by these compounds. With Chlor-Floc, waters are rendered attractive and palatable — factors which should serve as a motivation for the use of the tablets, and at the same time the waters are rendered microbiologically safe.

Applications

1. Outdoor living and the military.
2. The supply of potable water to scattered populace to whom the supply of purified water at central sources is impossible. Underdeveloped people often have to travel great distances and in certain instances have to pay excessive prices for their water, the tablets could enable the re-use of such water.
3. Squatter camps.
4. Hospitals in underdeveloped areas where e.g. tablets for 1l of water could be supplied to mothers for the preparation of water for the rehydration of infant foods.
5. Disaster areas e.g. floods, droughts and earthquakes.

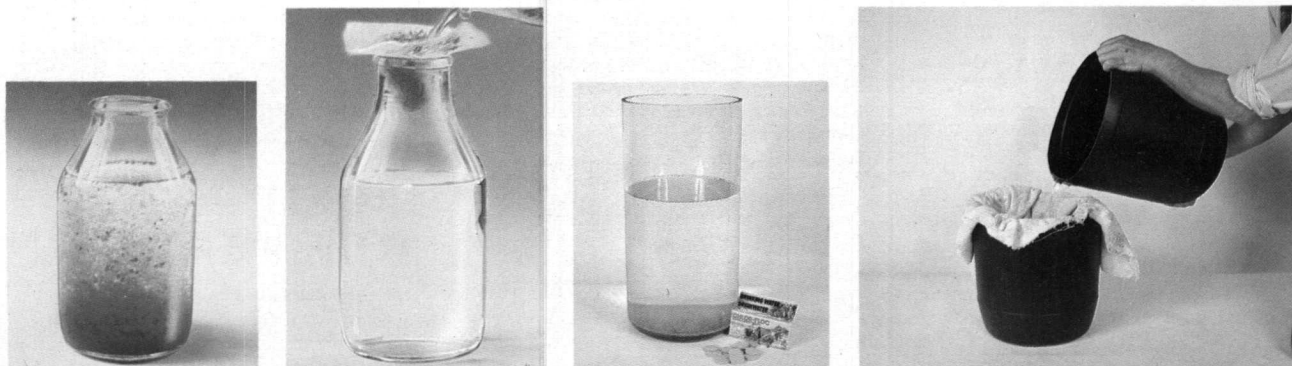
Illustrations (from left to right):

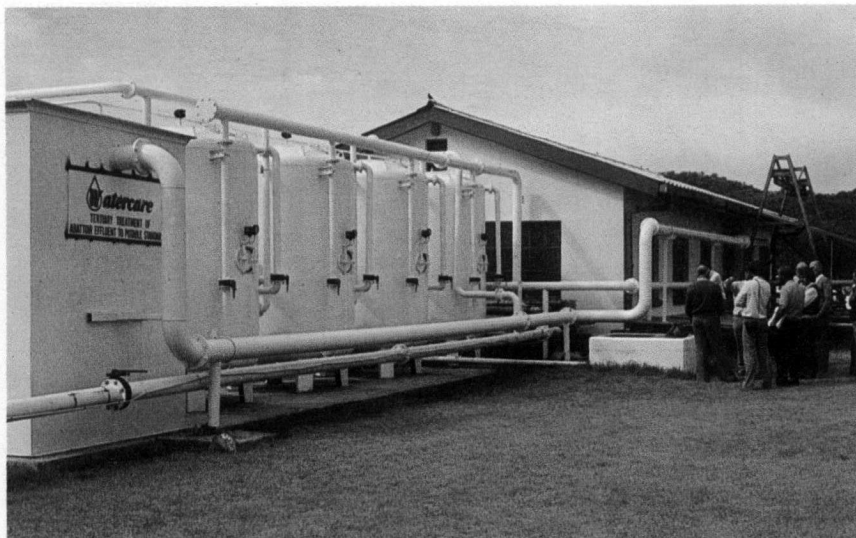
1. One 500 mg tablet separates pollutants from one litre of water.
2. The water is poured through a piece of cloth and a crystal clear disinfected water is obtained six minutes after the addition of a Chlor-Floc tablet.
3. 20 litres of putrid black marsh water clarified and disinfected 10 minutes after

the addition of one 10 gram Chlor-Floc tablet. Ten gram tablets are also illustrated.

4. The 10 gram tablets can be used with 25l plastic containers commonly available. The pouring of the clarified supernatant through a calico towel illustrated.

Enquiries:
Control chemicals
PO Box 39311
Bramley 2018
Tel 786-7166
Telex 42-4519 SA





Watercare's effluent treatment plants at Lobatse in Botswana were recently visited by a number of scientists and science administrators. The picture was taken during the visit.

Effluent treatment:

ACCENT FALLS ON BY-PRODUCTS

Watercare (S.A.) (Pty) Ltd is a South African Company and part of the RACEC group. RACEC is a wholly owned subsidiary of METKOR with main share holders Rentmeester, Volkskas, Iscor and Rembrandt.

The company specialises in the treatment of industrial effluents with the main emphasis on the recovery of valuable by-products, the conservation of chemicals and the reclamation of water.

Watercare (S.A.) (Pty) Ltd has designed, constructed and commissioned a fat and protein recovery plant for the Botswana Meat Commission at their Lobatse abattoir. The value of the recovered by-products has resulted in a payback period of less than two years on the total capital and running expenses of the treatment plant. The effluent is then treated further to potable water standards for an intended internal abattoir recycle of plus 70%.

Fat & proteins

At the Botswana Meat Commission Tannery at Lobatse, a recovery plant recovers fat and proteins from the lime liquors. The treated water is recycled back into the lime drums.

Projects for S.A. Breweries include lime softening of process water, the upgrading of combined bottlenwash, pasteuriser and floor wash water for reuse as pasteuriser and wash water in the brewery. Ozonation equipment has also been installed on the process water feed at breweries in

Gaborone and Lesotho. This treatment serves to disinfect the mains water, with the simultaneous reduction in organic levels, tastes and odours.

Process water treatment and bottlenwash water recycle systems have also been installed at various soft drink producing plants on the Reef.

A process developed by Watercare is used to recycle laundry wash water. The quality of the wash water is not only improved but unused detergent, heat energy and water are recovered in the process.

Effluent from an anodizing plant is treated to produce water acceptable to the local authority and aluminium hydroxide of high quality is recovered in the process.

The Watercare (S.A.) (Pty) Ltd offices are situated in Spartan, Kempton Park. The company is a turnkey contractor with a difference. It has its own laboratory for testing and chemical analysis of samples. The company does its own process development and has a staff of process, mechanical and electrical engineers. Development work is continuously carried out to solve new problems and to improve processes and existing treatment systems.

Enquiries:

Watercare (S.A.) (Pty) Ltd
PO Box 21
Isando 1600

EQUIPMENT

FLOAT CONTROL

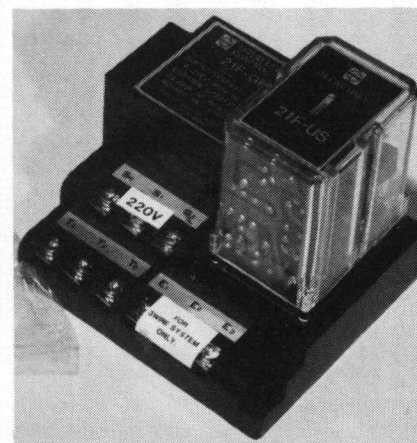
Float control systems, utilising three electrodes on a low voltage supply are common enough, but usually the system has to be built up from individual components. The Components Division of Rediffusion are now offering a new National unit, which incorporates the LV transformer, interposing relay, and marshalling terminals all on a compact base, all ready for 2-screw panel mounting.

Known as the 23F-G series, the floatless liquid level control unit is suitable for use on a standard 240 V mains supply, but it can be supplied for other voltages.

The relay is fitted with a plug-in base for easy servicing, and a built-in arrester circuit is provided to protect against surge from power sources, or lighting surge from the electrode side.

The built-in transformer provides a safe 12/24 V operating supply for the electrodes, and connections are designed for 3-wire operation. Thus the unit can be used for filling a high tank, or emptying a low reservoir.

Expected life electrical and mechanical are respectively quoted as more than 500 000 and 5 000 000 operations.



The unit shown in the pic is suitable for panel mounting, but an all-enclosed surface mounting version is also available. Enquiries to be directed to:

Electronic Components Division
Rediffusion
PO Box 39138
Bramley 2018

ROBOT INSPECTOR WITH TV

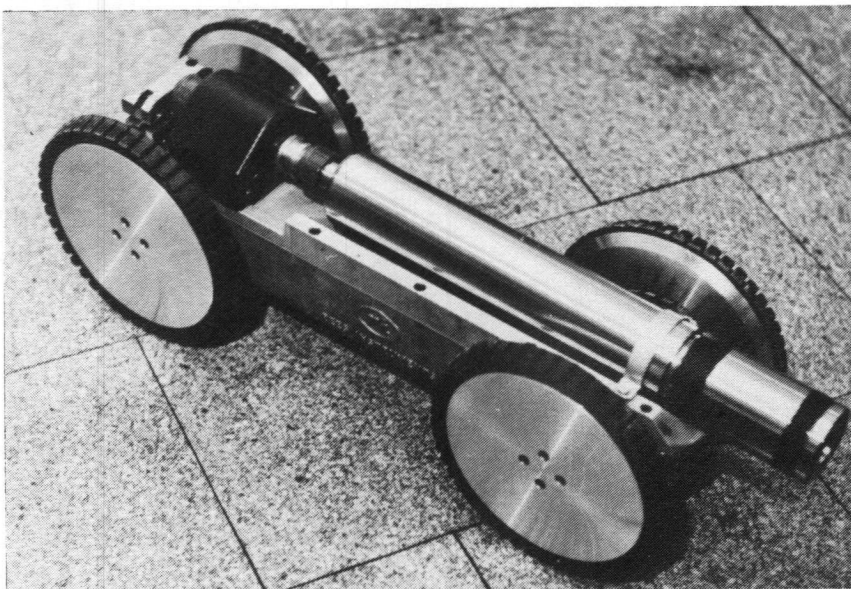
Rediffusion has also announced the availability in South Africa of a robot inspector — closed circuit television camera, waterproof, radiation proof, corrosion proof

EQUIPMENT

which can be lowered down into confined spaces, such as boreholes, or when such as a sewer has to be inspected, in the horizontal plane, kitted out with powered wheels so that it can move along the sewer by remote control, and with its built-in light source, provide a forward view of all parts of the sewer on a TV monitor at ground level.

Manufactured by Rees of UK, and distributed in RSA by Rediffusion, the R95 system can be supplied for installation in a suitable van or trailer, to provide complete mobility for the monitor, and drum of inter-connecting cable complete with electronic cable counter so that the exact position of the camera in the sewer can be shown on a digital display. By utilising a standard National video recorder, a continuous record of the complete sewer can be made, complete with on-the-spot, or later-added, commentary, thus providing a much more detailed and accurate record unmatched by any other method.

The camera body is encased in ENS



stainless steel, with an overall diameter of 40,5 mm. It employs a high sensitivity vidicon tube, giving better than normal resolution of 600 plus TV lines. Such is the

sensitivity, that the camera will operate with less than 5 lux.

Enquiries to be directed to the CCTV Division of Rediffusion.

Water economy measure:

NEW W.C. CUTS WATER USE DRASTICALLY

After several years of continuous research in the fields of hygienic toilet systems, and water-saving, a Pretoria businessman, Mr. John Ballam, has developed and patented what is claimed to be the most advanced toilet of its kind in the world.

The compact all stainless steel w.c. pan is unique in that, whilst the system incorporates wet wall flushing, no cistern is required, and the consumption of water can be varied from one to three litres per flushing; whereas a conventional cistern flushing-type toilet consumes no less than eleven litres per flushing.

A water-seal ensures a high standard of hygiene, there are no pipes or fittings exposed to vandalism — in fact, the only external moving part is a small but robust foot pedal to activate the flushing mechanism, and the inventor claims the system to be virtually maintenance free and blockage proof. All components are manufactured from anti-corrosive materials.

The introduction of the toilet has aroused considerable interest throughout the Republic of South Africa and neighbouring states, especially in Government Departments. The Department of Education and Training, in particular, is installing large numbers throughout the Cape, whilst upgrading school sanitation.

By installing the "Ballam-Waterslot" a water saving of up to 1000% per toilet flushing, and up to 35% of the daily consumption of drinkable water used by a family unit, is effected.

The w.c. pan may be installed under a variety of conditions, in particular if it is embodied with a septic tank lay-out it may also be used as a means of disposal of domestic organic waste matter.

In rural areas the use of the toilet eliminates nauseating odours, puts an end to fly breeding in otherwise unsanitary pits or bucket systems, and plays a major part in preventing the spread of disease in human beings, apart from also preventing infection of cattle from veld pollution. Thus, the adoption of the "Ballam-Waterslot" is an essential item in cholera affected areas where hygienic sanitation is required to break the links in the chain of this particular disease.

The water supply to the flushing mechanism may be of high, or low, pressure and is controlled by an S.A.B.S. approved, world patented, "Stilflo" valve.

A detailed brochure is available together with explicit installation literature, apart from which the distributor offers a professional consultancy and design service, ranging from homestead to township sanitary requirements.

Enquiries:
Ballam-Waterslot Toilet Systems,
PO Box 40482
Arcadia 0007
Phone (012) 47-6070



EQUIPMENT

U.F. AND R.O.

P.C.I. Ultrafiltration is used for concentration and fractionation of whey and skim milk, the concentration and purification of enzymes, the recovery of valuable by-products from wood pulping effluents, etc.

P.C.I. have now produced a new design incorporating a twin port end cap which provides a higher energy efficiency. The extra energy saving is achieved by having a configuration of fewer tubes in parallel and more in series within each module. This reduces the energy consumption by 33%.

The plant is normally fitted with 35 stainless steel modules of Type B1 design, 3.66 m long. The circulation pump is a Fristam single stage centrifugal type. The other module within the stack acts as a heat exchanger to ensure the temperature of the process liquor is maintained at the required level.

The plant is also fitted with an automatic cooling water control valve and a recirculation temperature control. Electric actuators are fitted to the pump and module outlet throttle valves in order that the valves may be easily adjusted during normal operation. Pressure indicators are fitted to the pump inlet, pump outlet and module inlet.

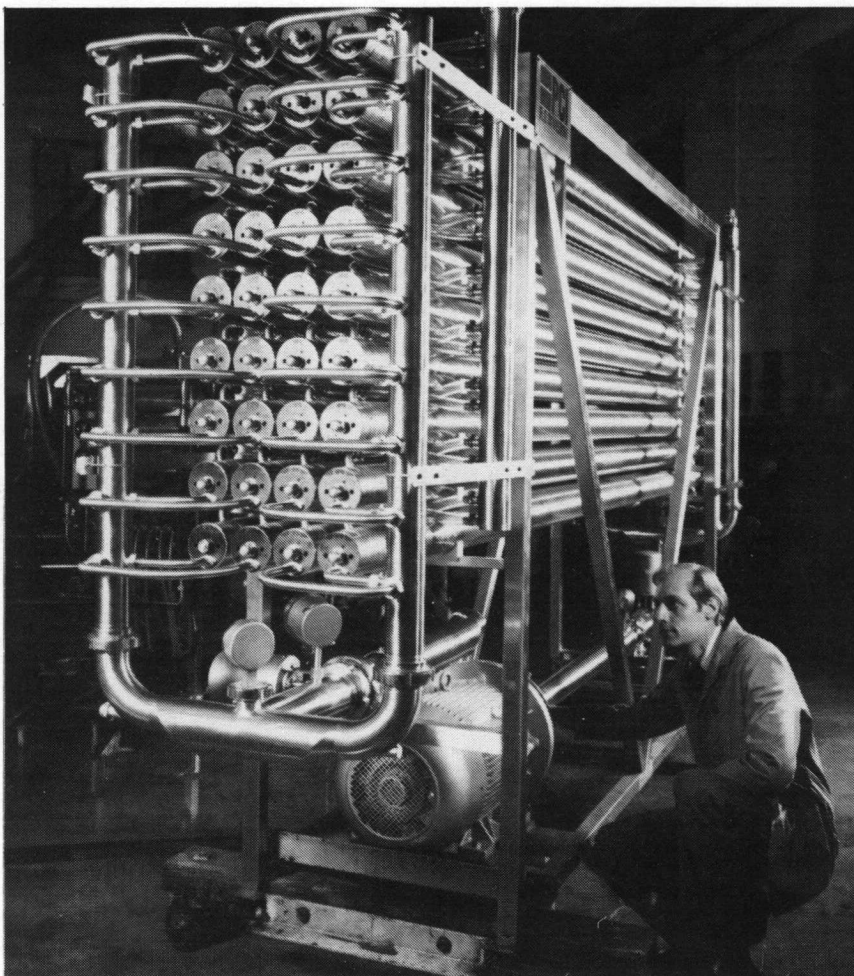
Membrane Area — 91 m²

Capacity — Depends on the application and operating conditions, but normally 2000 to 6000 l/hr of permeate.

Operating Pressure — Maximum 10 Bar, normally 6 Bar.

Operating Temperature — 5°C to 60°C

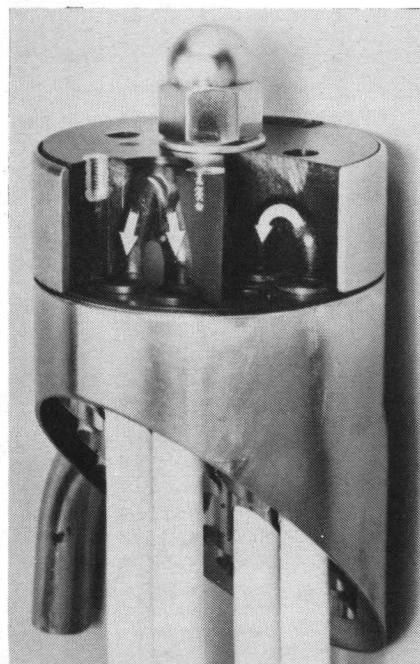
Motor — 30 kW — 380/415 volts



Power Consumption — 61/55 Amps
Dimensions — 4.170 m x 0.78 m x 2.38 m high.

The unit is normally operated as one stage of a continuous multi-stage system. It may also be used as a single stage concentrator.

Most P.C.I. process R.O. plants presently in commercial operation in the dairy and food industries contain membranes manufactured from cellulose acetate, (CA) which give an excellent performance but have limited temperature and pH capability which restrict their use.



UF module in section.

Enquiries:

Mr CH Tilley
Marketing Services Manager
Reverse Osmosis Division
Paterson Candy
International Ltd
Laverstoke Mill
Whitchurch
Hampshire RG28 7NR

Paterson Candy International Limited also announce the development of a new non-cellulosic membrane (Type ZF 99) for process reverse osmosis. The new membrane has substantially improved pH, temperature and pressure resistance, improved separation performance and increased capacity that will now allow reverse osmosis to be used for a much wider range of process applications, such as dewatering of:

- Pulping Effluents
- Sugar Solutions
- Distillery Effluents
- Molasses Effluents
- Starch Solutions
- Fruit Juices
- Antibiotics

New Membrane

The wide pH range (3 to 11) and temperature capability (up to 80°C) extends the application of P.C.I. R.O. systems to a range of new applications and operating conditions not previously available to membrane systems.

A comparison with CA Membranes is shown in the diagram.

The very high rejection properties of P.C.I.'s ZF 99 result in a permeate (removed water) of substantially improved quality which can, in many cases be reused as high grade water. Industrial operation on lactic acid whey during six months at Gervais Danone, France, has demonstrated an 80% reduction in permeate COD compared with cellulose acetate membranes. The membrane also shows a substantial ability to retain alcohol and other small molecules and gives better than 99% rejection from a 1500 mg/l sodium chloride solution. Membrane comparison tests on sweet whey showed an 80% reduction in BOD levels compared to CA when tested under the same operational conditions.

The ZF 99 exhibits a much higher permeation capacity in almost all applications, which may be further increased by operating at higher temperatures where the process permits. In most cases this means that the reduction in plant cost more than off-sets the higher costs of the membrane.

The new membrane technology has been

in use in the water and sea water R.O. field for two to three years.

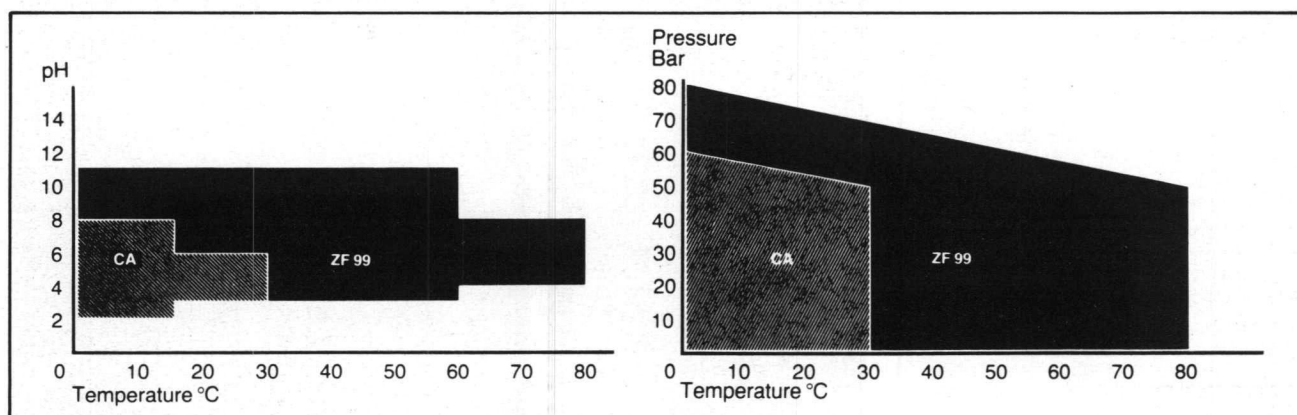
P.C.I. have used the new membrane for process application since October, 1981 when an installation at Gervais Danone, France was fitted with the new membrane.

Laboratory and on-site trials on a wide variety of process applications since

EQUIPMENT

September 1981 have demonstrated the excellent performance of the new membrane and its excellent mechanical reliability.

Enquiries: As above.



New Waste-tech plant at abattoir:

LESS POLLUTION — MORE PROTEIN

A Protein Recovery plant recently went into operation at the Karoo Meat Corporation Abattoir in Balfour. It is the first of its kind to be installed at a red meat abattoir in the Republic of South Africa.

The protein recovery plant was designed and built by Waste-tech to recover protein from the effluent generated at an abattoir.

Waste-tech, controlled by D & H Waste Management, is a subsidiary of Darling & Hodgson Limited, which in turn is a subsidiary of the Gencor Group.

Waste-tech has been involved in the treatment and disposal of hazardous and toxic wastes and effluents at regional treatment and disposal facilities for over ten years.

Abattoirs with byproducts plants usually generate an effluent containing soluble blood, both suspended and emulsified fats and suspended solids.

Abattoirs without byproducts generate effluents with a much higher pollution load. But both types of abattoirs normally degrade these effluents by biological treatment.

Waste-tech have introduced a more efficient process which recovers 60 cents worth of protein for each animal which is slaughtered. Waste-tech is able to precipitate the blood protein, break down the fat emulsions and recover the protein and fat for processing via a rendering plant, effectively reducing the pollution load in the effluent by between 75 and 95 per cent.

The blood precipitation and emulsion cracking process was developed by one of the world's leading authorities on water pollution control. The product recovery process by air flotation has been designed by a leading international firm of water and wastewater consulting engineers.

For those worrying about the erection costs of this protein recovery system — its capital cost is less than that of activated

sludge or a biofilter system. It is in fact only 25 percent of the cost of conventional destructive biogradation processes currently in use.

Waste-tech protein recovery plant is able to give a return on capital invested in this process ranging between 15 and 25 percent as a result of the profits earned from the sale of the recovered bloodmeal.

The opening of the protein recovery plant at the Karoo Meat Corporation in Balfour was attended by a number of dignitaries from Kanhym; Consultants Geustyn, Forsyth; Cohen; Linsell; (Meiring & Partners); Time Projects; O'Connell Manthe; Government Department's Water Affairs; Abattoir owners; Festive Foods; Farm Fare; ICS; Abattoir Corporation; the Germiston Municipality; Rainbow Chickens; Water Research Commission and the Balfour Municipality.

As most industrial wastewater streams are most economically handled by various degrees of pretreatment on the factory premises in order to concentrate the pollutants before removal for final treatment and disposal, Waste-tech offers a total waste management service.

This project management and consulting service offers clients Waste-tech's in-house expertise for the process and engineering design, turnkey construction and operation of effluent treatment plants on the premises.

The service offers :

A laboratory and process investigation of effluent or waste systems.

Process and engineering design

Turnkey plant construction

Financing

Operation of the plant.

The Karoo Meat Corporation's Abattoir protein recovery plant was installed on a turnkey design and construction basis and is proving to be highly successful.

Enquiries:

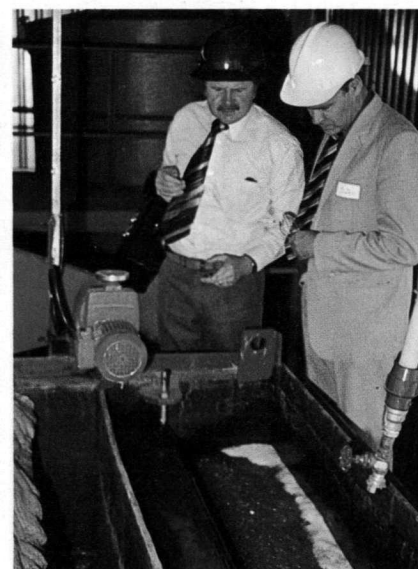
D & H Waste Management (Pty) Ltd.

P.O. Box 41104

CRAIGHALL

2024

Tel. (011) 788-7300



Pictured during the opening of Waste-tech's Balfour plant at an abattoir are Dr OO Hart (left), senior adviser at the Water Research Commission, and Mr PE Odendaal, chief adviser at WRC.

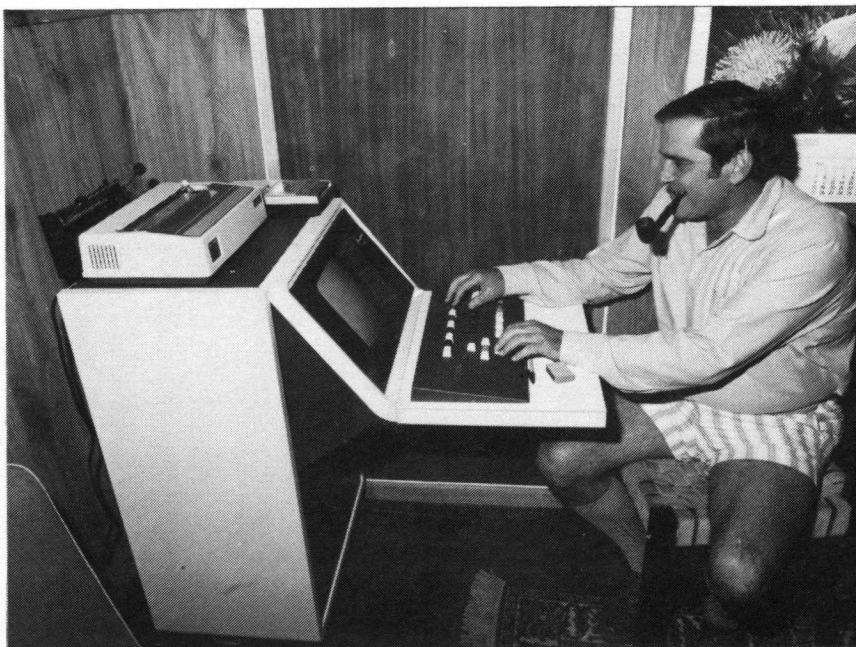
EQUIPMENT

COMPUTER AID TO IRRIGATION

Just put out of your mind right away, any ideas that everything is left to mother nature when it comes to growing grapes in the Cape. Very little is left to chance these days, because the Cape farmer now knows as much about sophisticated computer controlled systems as he does about his Tinta Baroccas and Bukettraubes. The image of the Cape farmer in his fields and orchards might still prevail, but in actual fact he might now be spending most of his time in his compact, centralised control room checking his computer print-outs.

Many factors contribute to successful farming, but by far the biggest single one is adequate and correct irrigation. Many different systems of irrigation control have been on the market for some time, basically controlling spray or drip-feed by means of automatic valves on a time sequence controlled system. Now, thanks to the Communications Division of Motorola SA, a more accurate and cost effective arrangement is available to all South African farmers.

The prime difference between the existing systems and the relatively new Motorola system is that the former are based on a fixed time sequence, in other words valves are made to open and close for fixed time inter-



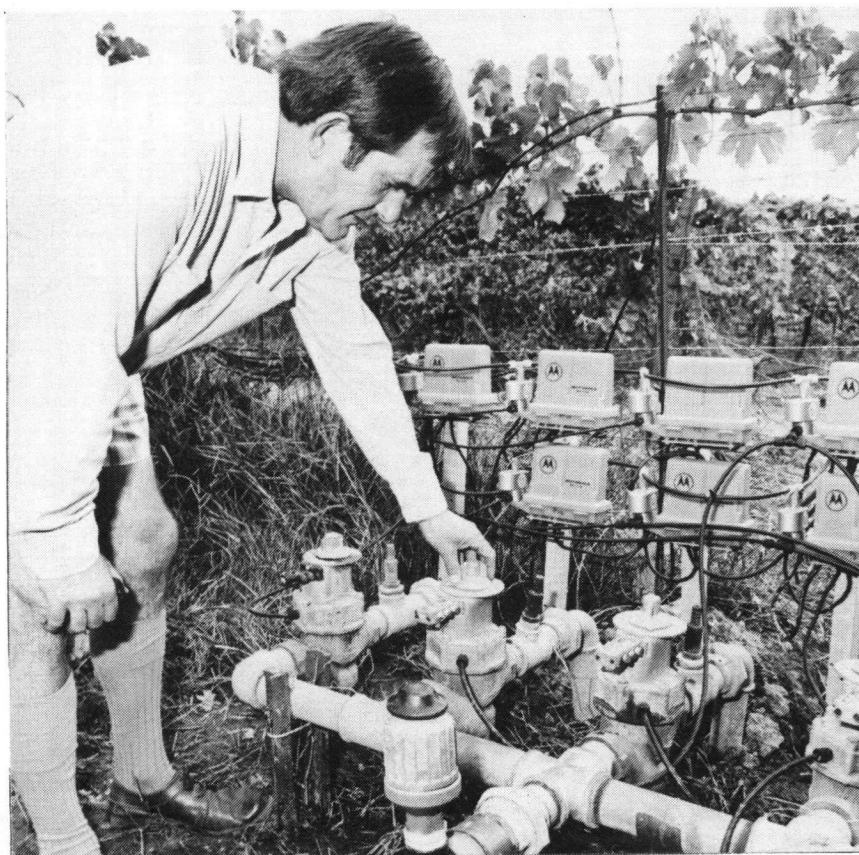
Mr Pieter Redelinghuys at the console of his Motorola system.

vals irrespective of flow rates. The Motorola system measures the actual flow at the points of distribution, and ensures that sector by sector, the correct amount of water actually reaches the plants. Thus, irrespective of blocked jets, burst pipes, leaky connections etc, the correct flow rate is constantly monitored, and assured, 24 hours a day. In the event of a burst, or someone

manually opening an incorrect valve, an alarm will be registered and logged on the computer print-out. Let us take a look at two factual case histories:

Pieter Redelinghuys has a 43 ha farm called St Pieters Roche, near Paarl, almost exclusively vines, but with a couple of big tunnels for cucumbers — he looks on cucumber growing as a hobby, but the two crops each year certainly help pay the overheads. He installed a semi-automatic system in 1972, which he developed over the following five years. He gradually changed from a sprinkler to a drip system, primarily because he wanted a fair degree of accuracy of water volumes, and a finer overall control at the points of contact. Taking water from two bore-holes and the Berg River, his semi-automatic system gave him a time cycle of 16 hour/day for 6 days/week. In order to achieve a full 24 hour cycle, he would have had to reinforce his installation by a further 75 HP, to ensure adequate compensation for losses etc. Utilisation of the Motorola computerised irrigation control system now provides irrigation on a 24 hour cycle, 7 days a week as the computer is at all times fully in control, automatically controlling both sequence and quantity of water as instructed by Pieter, and each sector gets exactly the right amount of water. It even automatically back-washers the filters for the drip-feed system!

In his little control room, beside the house, Pieter has his computer, and on his Motorola terminal screen he can call up the "menu", which is merely a listing of all the different functions handled by the system. If for example, he wants to remind himself as to how much water he has asked for in each of his 29 sections or "blocks" as he calls them, a touch of the keyboard will bring up a complete listing on his screen, and tell him which "blocks" have been irrigated, and which are in progress, etc. Either automatically, or on demand, a printer will provide him with a hard-copy record.



Mr Redelinghuys inspecting the remote control valves of the system.

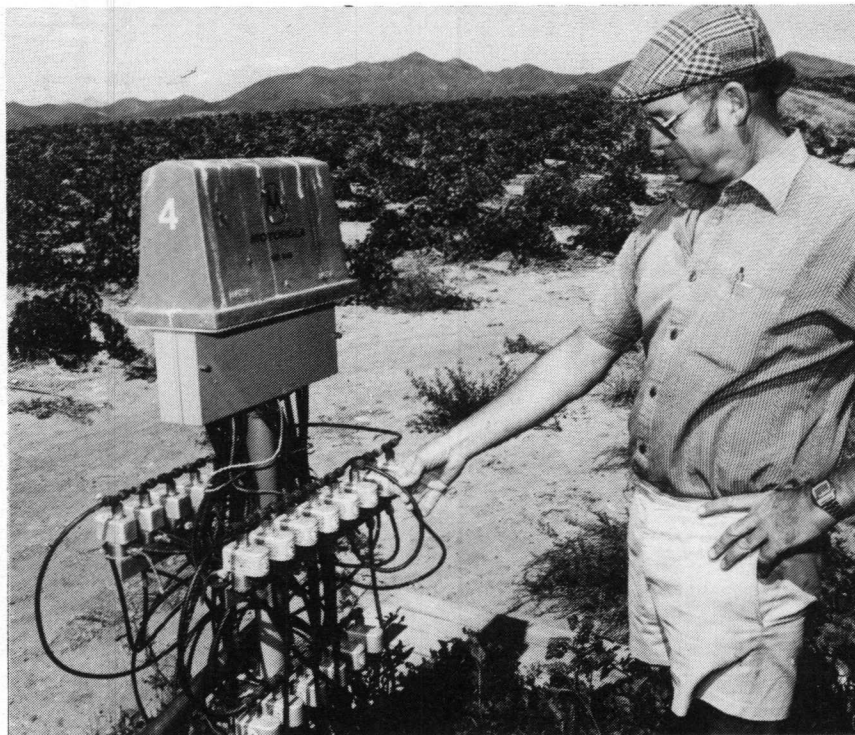
EQUIPMENT

Johan Bruwer has a 200 ha establishment called "Prospect Farm" near Ashton, and he decided as long ago as 1979 to get on-stream with "armchair farming". Most of his farm is devoted to vines, with a small proportion for canning peaches. Johan's reasoning for computerisation was different to that of Pieter's. Because of the overall size, Johan really needed a manager, but he did not relish the idea of delegating, as he really enjoyed farming himself. Thus he spent the money on a Motorola system, and saved R20/30 000 a year on NOT having a manager.

Larger

His system operates in the same way as Pieter's, but is a much larger installation classified as a type MIR1080. He has a mimic diagram on the wall of his control room showing, by means of little coloured lamps, the status of every pump and valve on the system. He anticipates extending his farm in the near future, and when this happens it will just be a case of hooking the extension into the existing system, which has adequate capacity.

It is possible to have a fully automated system, with feed back of all the necessary critical factors such as humidity, water penetration, air temperature and so on, into the computer by means of special sensors. The computer would then automatically work out the correct water flow rates, and irrigate accordingly. However, in general, farmers are not keen on this idea and much prefer a hands-on control system where



they personally can make day to day decisions.

Enquiries:
Communication Group
Motorola SA
PO Box 39586
Bramley 2018
Tel (011) 786-1184

CONFERENCES

(From page 44)

Enquiries; Aqua Expo '83 Conference Committee, PO Box 1088, Houston, Texas, USA.

GEOLOGICAL TECHNOLOGY

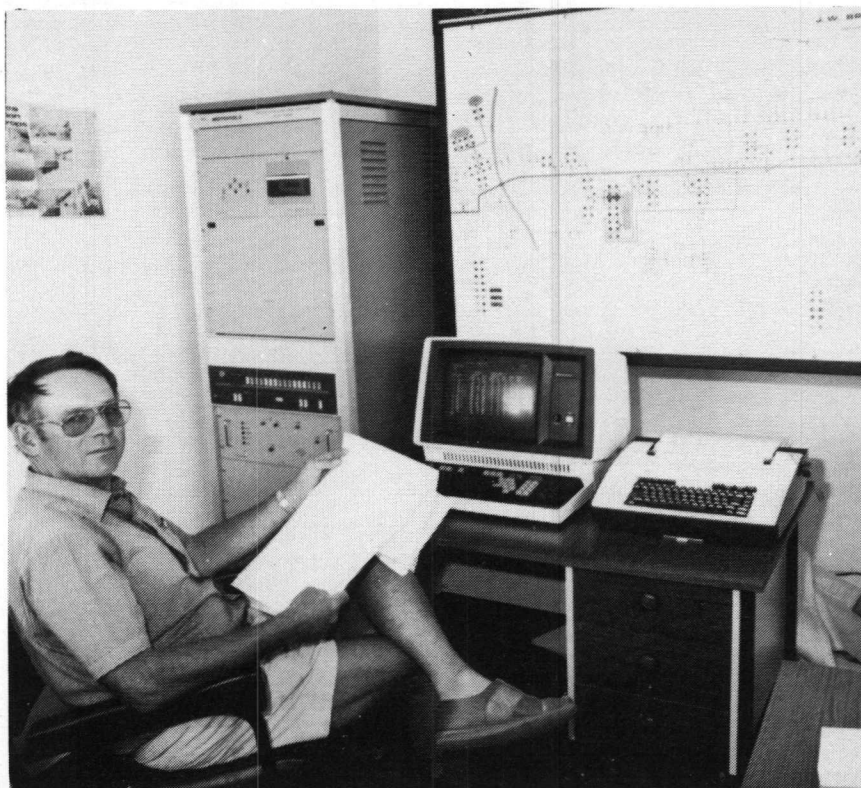
Two concurrent exhibitions *Aquatec Italia* and *Geotec* will be held in Milan, Italy from March 10 to 13, 1983.

Geotec will concentrate on geological technology and Aquatec on water installations, collection, research, treatment and transport. Enquiries: Comis Lombardia, Via Boccaccio, 7, 20123 Milano, Italy.

PUMPS

The eighth technical conference of the British Pump Manufacturers' Association: *Pumps — the heart of the matter*, will be held from March 29 to 31, 1983, in Cambridge, United Kingdom. The Association will ask authors to focus on energy conservation, meeting the demands of the Third World, and materials technology.

Enquiries: British Pump Manufacturers' Association, 37 Castle Street, Guildford GU1 3UQ, Surrey, UK.



Mr Johan Bruwer in front of the terminal screen of his computer, and (above right) in his vineyard checking the valves.

CONFERENCES AND SYMPOSIA

PUMPS

An international pump show: *World of pumps*, will be held from December 5 to 7, 1982 in Chicago, Ill., USA.

Enquiries: Stephen Taufen, World of Pumps, PO Box 9368, Seattle WA, USA.

The first European conference on small hydro will be held in Monte Carlo, Monaco from December 6 to 8, 1982.

The conference is designed to bring together operators, manufacturers and planners to exchange information and experience on this rapidly expanding technology. It will cover turbines and generators, civil works, case studies, control equipment, micro hydro and other topics.

Enquiries: The Editor, Water Power & Dam Construction, Quadrant House, The Quadrant, Sutton, Surrey SM 2 5AS, UK.

REMOTE SENSING

An International symposium on remote sensing: *Remote sensing for exploration geology*, will be held from December 6 to 10, 1982, in Fort Worth, Texas, USA. The programme will cover a review of the state-of-the-art applications of remote sensing in exploration programmes and research and development.

Enquiries: Dr Robert H Roger, Environmental Research Institute of Michigan, PO Box 8618, Ann Arbor, Michigan, 48107, USA, TWX 710 822 9300.

GROUNDWATER

A *Symposium on parameter estimation for groundwater* will be held in San Francisco, California, USA from December 7 to 15, 1982.

Enquiries: American Geophysical Union, 2000 Florida Avenue N.W., Washington DC 2009. TWX 710 822 9300.

ENVIRONMENTAL ENGINEERING

The ninth *National convention on environmental engineering* will be held in Jaipur, India from January 5 to 7, 1983.

The conference is sponsored by the Institution of Public Health Engineers, India, and will present papers on many topics of interest to environmental engineers, including research and pilot plant studies, academic and practical field problems and legal aspects in environmental engineering.

Enquiries: Shri SK Neogi, Secretary General, IPHE, India, 1 Garstin Place, Calcutta-700001, India.

TECHNOLOGY TRANSFER

An exhibition and conference *Agua Expo '83* on technology transfer will be held from March 1 to 4, 1983 in Acapulco, Mexico. Papers will deal with well and borehole construction, desalination, sludge treatment and disposal, water treatment and other themes.

(To page 23)

finally . . .

Sumner is here

'Camping near open water', (Oom Louw Schalken said) 'is not always as quiet and as peaceful as that time when Saartjie Lepellip dropped a bottle of belladonna into the *Nagmaal* wine, you know.

'Take the vermin around here - they're no meek and mealy-mouthed city moths who dine off Harris Tweeds, you know. There were (at the last count, no doubt) fifty million kinds of water scorpions, spiders, snails, snakes and mosquitoes, not to mention the *real*-ly irksome pests, slithering, slipping and sliding, and in the case of the mosquis, strafing, in, around and over you and yours.

'And let me tell you something for nothing: they are as united in this one thing as those nations would like to be - they want to get your inside out and your outside off in no time flat so as to make a meal, so to speak, of your blood.

'"Fool thyself not"', as Hamlet said to the skull, to get their way with you they will tear, chew, sting, gnaw, bite, pierce and puncture you until your veins have run as dry as a beer barrel at a *Boeredag*. In fact, even the late great Bader's legs were not safe from them: if the mosquis do not get you then the borer beetle will.

'The only remedy I know is to let your blood go out altogether - which is awfully bad because it makes a repulsive gurgling, drainy sort of a sound.

'No, just listen to those mosquis homing in on a C minor note and you will realise that all is not quiet on the western front - in fact, the way things seem around here is quite misleading. Take those two swallows swooping over the water now. Pretty as a painting, you could say. But as you well know, two swallows do not make a Sumner . . .'

SA WATERBULLETIN

SA Waterbulletin is 'n kwartaallikse nuusbrief oor water en waternavorsing wat uitgegee word deur die Suid-Afrikaanse Waternavorsingskommissie (WNK), 'n statutêre organisasie wat in 1971 by Wet gestig is.

Intekening is gratis. Stof in dié publikasie weerspieël nie noodwendig die oorwoë menings van lede van die WNK nie, en mag hergebruik word met erkenning van die bron.

Redaksie: WNK, Posbus 824, Pretoria 0001, Republiek van Suid-Afrika. Tel (012) 28-5461.

Redakteur: Anton Prinsloo
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Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

Editorial offices: WRC, PO Box 824, Pretoria 0001, Republic of South Africa. Tel (012) 28-5461.

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