SA WATERBULLETIN

SPECIAL ISSUE ON TEXTILES EFFLUENT RESEARCH – JANUARY 1983

New technology brings benefits:

WATER AND EFFLUENT MANAGEMENT IN THE TEXTILE INDUSTRY

This special edition of *SA Waterbulletin* reviews specific problems faced by the wool and cotton textile industry, and the research sponsored jointly by the Water Research Commission and industry which has solved some major problems and has developed the technology which is now available to the six hundred-odd wool and cotton textile factories in the Republic of South Africa.

On these pages some of the processes are discussed in sufficient detail to satisfy the technically-minded, and the screened boxes contain pointers to management of the advantages of the processes which will accrue to the manufacturer in terms of water savings and the recovery of chemicals and energy and reductions in cost of effluent discharge to municipal sewers.

Introduction

The Republic is a water-scarce country. This is evident from the country's water balance which shows that the maximum available resources per annum amount to 34,4 milliard (10^9) cubic metres. The rapid growth in water demand is reflected in the following figures: in 1975 30% of the available water was utilised; by the year 2000 54% will be utilised; by the year 2020 (a mere twenty years later) all available supplies will be utilised.

Simultaneous with the growth in demand the country is facing an increase in water pollution – the quality of the water returned to rivers and streams is deteriorating. Unless research is done on a national basis to combat pollution and to achieve maximum production per unit volume of water used, a serious breakdown in water supply will result.

Estimates are that industrial and domestic use will account for 33% of the available supplies by the turn of the century. Water economy in industry will be a determining factor in the allocation of additional freshwater supplies to industry.

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A typical example of effluent (top) at a cotton/synthetic fibre dyehouse and (below) the self-evident success of the Pollution Research Group's treatment of the effluent.

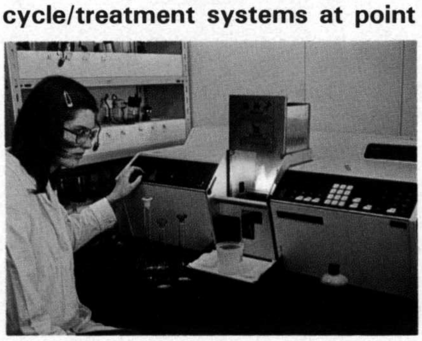
From page 1

Against this background the textile industry in South Africa emerges as a large user of water (typically 200 to 400 litres are needed to produce 1 kg of fabric), and its concomitant effluent discharges create many problems in terms of water quality protection. This is because textile effluents contain a wide variety of chemicals including dyestuffs, detergents, acids, alkalis, salts, heavy metals and organics. Many of the organic compounds are relatively non-biodegradable and these, together with colour and salts, cause discharge problems

Since its inception in 1971 the Water Research Commission has been identifying problems in the fields of water supply, optimal water usage, effluent treatment and effluent reclamation, and as far as the textile industry was concerned a Coordinated Research and Development Committee was formed which compiled a master plan outlining the water-related research and development needs of this industry. This was important because the industry is a major one in South Africa with more than 600 factories which support approximately quarter of a million people in the textiles and clothing manufacturing sectors.

The main objectives with this research were to optimise processes developed for increasing the efficient use of water, i.e. to effect maximum production per unit volume of water by ensuring maximum reuse of water, reuse and recovery of chemicals to reduce pollution.

The ultimate aim was to design closed-loop water and effluent recycle/treatment systems at point



Miss Heather Logan at the PRG's atomic absorption photospectrometer.

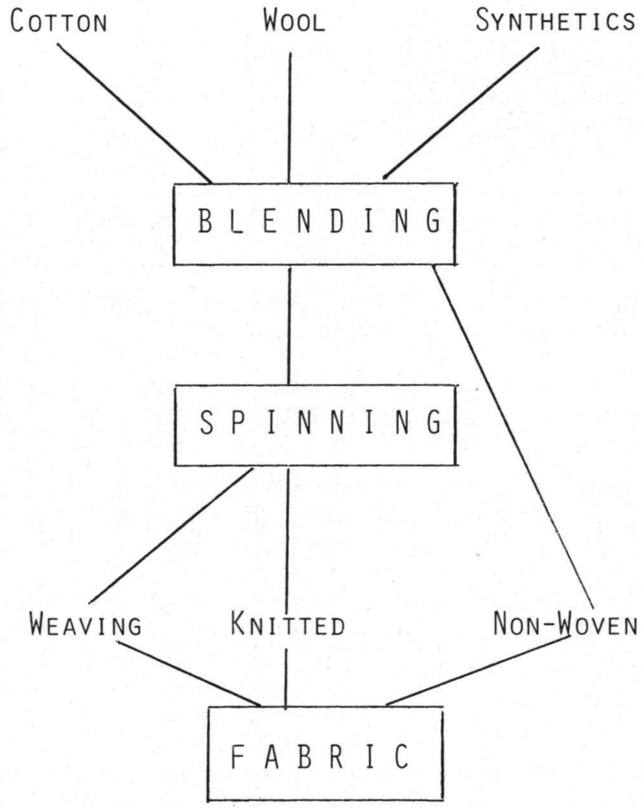


Figure 1: Processing modes of the textile industry.

source and this was afforded particular emphasis in the research and development programme since these would result in significant benefits and assist in meeting the overall objectives.

The Commission approached the University of Natal with a request that a centre of expertise in this field be developed within the University's Chemical Engineering Department. As a result the Pollution Research Group (see back page) was established.

An investigation by the Group identified four major point sources of pollution in the textile industry – these were effluents from dyeing and printing, scouring, sizing/desizing and wool scouring. The Group was then contracted by the Commission to develop closed-loop water and effluent treatment/recycle systems for these sections of the industry.

Because the textile industry has many diverse wet processing operations and also processes a variety of fibres – cotton, wool, polyester, nylon, acrylics – effluents of extremely diverse compositions are produced, which require to be suitably treated to meet effluent standard specifications for discharge to sewers and/or the natural drainage systems, or for direct internal reuse. It was imperative that a variety of water and effluent treatment systems be investigated, from which those processes could be selected to meet the specific needs of the textile industry.

The processing modes of the textile industry are shown in Figure 1. In the *wool sector* the main effluents are from wool scouring and wool/synthetic fibre dyeing. In the *cotton sector*, the high strength effluents are from sizing/desizing, scouring and dyeing and printing.

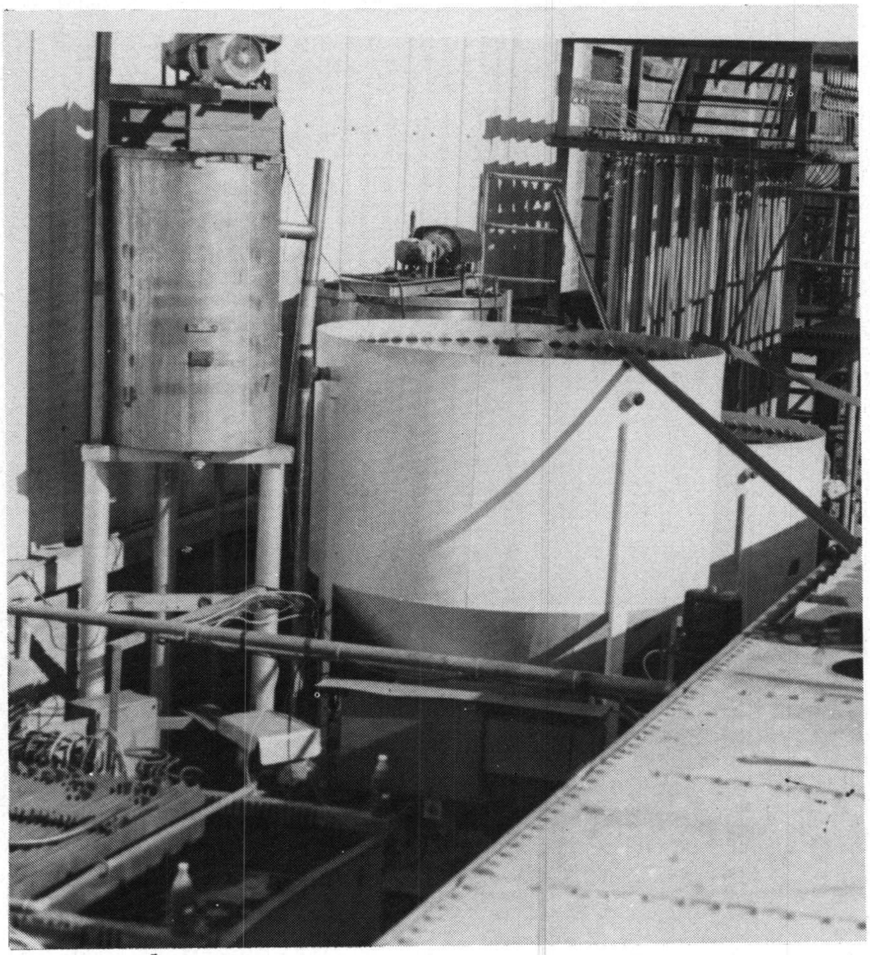
In the research done so far on laboratory and pilot scale, treatment/reuse technology has been developed for effluents emanating from

- the wool/synthetic fibre dyehouse
- wool scouring
- sizing/desizing
- cotton/synthetic fibre dyeing and printing.

Research on the treatment of *cotton scouring* effluents will commence during 1983.

In the sections dealt with in this bulletin some of the salient findings are highlighted for the specific benefit of the industrialist.

Wool/synthetic fibre dyehouse effluent treatment and reuse



The pilot plant for the treatment of wool/synthetic fibre dyehouse effluent at Veldspun Ltd, a worsted textile mill in Uitenhage, CP. A full-scale treatment plant is currently being constructed and will be commissioned in 1983.

The problem

These dyehouses process wool, acrylic, polyester and sometimes viscose fibres either singly or in blends in the form of yarn, tops or pieces. The effluents are usually acidic and contain residual colour from a variety of dyestuffs, heavy metals (such as copper, chromium, cobalt and nickel) and a range of organic chemicals. The residual dyes constitute unacceptable visual pollution and coupled with the organic auxiliary chemicals, are responsible for high chemical oxygen demand values. For reuse of reclaimed dyehouse effluents for dyeing, the quality standards are exacting. Particular attention must be paid to colour, calcium, heavy metal ions and suspended solids. The anionic and cationic surfactants used in dyeing must be removed from the effluent to prevent complexing either with each other or with dyestuffs.

The treatment

A 85 m^3/d closed-loop treatment/recycle pilot plant was installed in 1978 at Veldspun Ltd, the largest worsted mill in South Africa. The pilot plant was operated for 21 months to demonstrate the appli-

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Pointers to management – wool/synthetic fibre

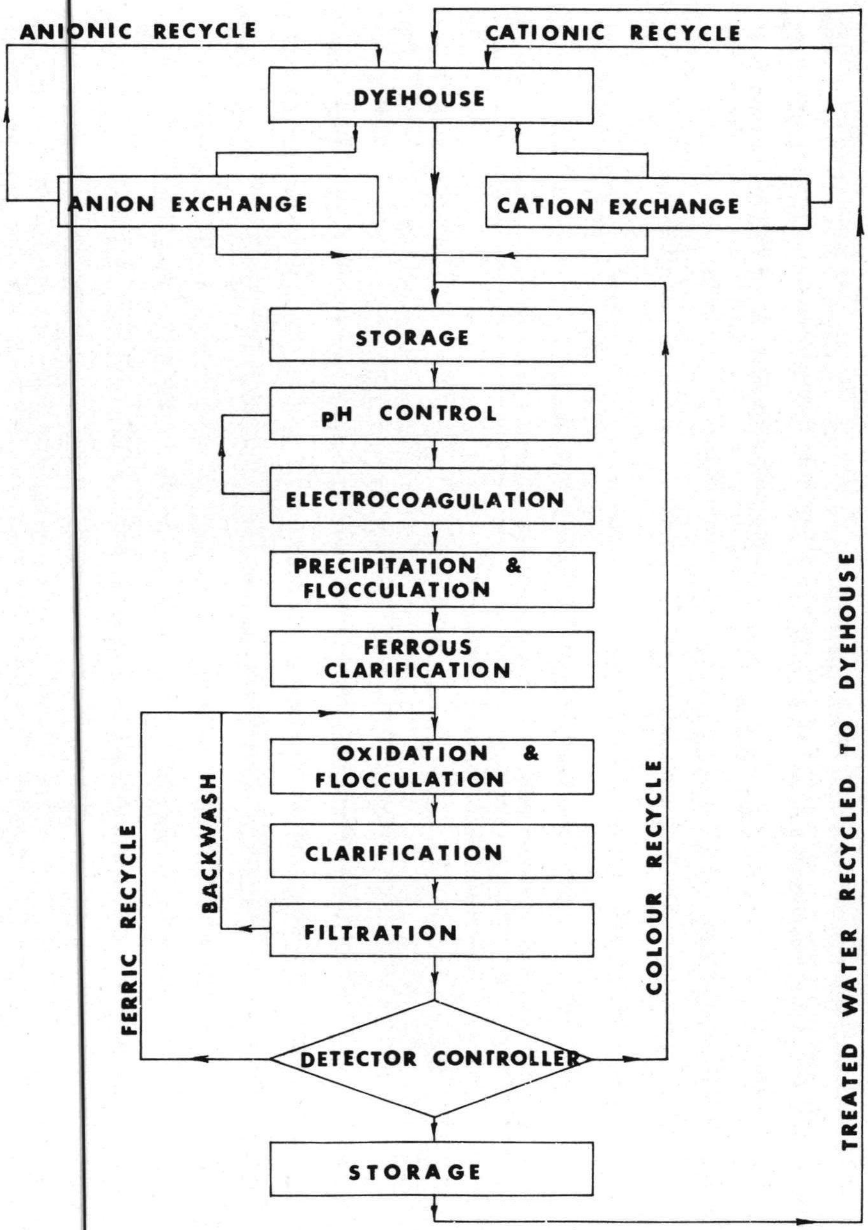
- Suitable for wool, acrylic and polyester dyeing wastewaters
- 85 to 95% water recycle
- Quality of treated effluent suitable for dyeing
- Complete removal of chromium and heavy metals
- Anionic and cationic surfactants recovered for reuse
- Automatic plant with minimal operator supervision
- Treated water costs comparable to normal process water costs in many parts of the country
- All dyeing trials from pilot plant were successful
- Full-scale treatment plant under construction

cability of the treatment technology and to develop and optimise the design parameters for full-scale treatment plants. The process equipment consisted of the unit operations of ion exchange, electrocoagulation, two-stage clarification and sand filtration. The treatment system had two main functions: firstly, to remove charged surfactants by ion exchange for reuse and secondly, to decolourise and remove heavy metals from the effluent by coagulation.

Effluents containing anionic or cationic surfactants were discharged to separate sumps and were treated by their respective ion exchangers. The outflows from these were mixed with the remainder of the dyehouse effluents. The mixed effluent was treated by electrocoagulation using sacrificial iron anodes to give a concentration of 100 mg/ℓ of ferrous ion. This reduced hexavalent chromium in the effluent to the trivalent state and this along with the other heavy metals, were precipitated as their hydroxides. Because of the high solubility of ferrous hydroxide in the effluent, the overflow from the ferrous clarifier was oxidised under alkaline conditions to produce ferric hydroxide which has a solubility limit of 0,2 μg/ℓ. The ferric hydroxide flocculate was then removed from the treated effluent by clarification and filtration.

The results

The performance of the pilot-plant was excellent with over 90% removal of the surfactants, complete removal of chromium and other heavy metals and over 90% colour removal. The colour of the treated effluent, measured in ADMI units, was consistently below 65 which was very close to the process water values of 30-50. A high precision colour detector-controller was developed and this was used successfully to monitor the quality of the final product water from the pilot-plant. The treated effluent was recycled back to the dyehouse and reused to dye over 50 000 kg of fibre. Five production dyeing machines were used for this purpose and the trials covered the full range of the various dyeing procedures found in this sector of the textile industry.



Line diagram of unit operations: treatment of wool/synthetic fibre dyehouse effluent.

Two main problem areas were encountered during the pilot-plant investigations: poor clarification of both the ferrous and ferric hydroxide clarifiers and subsequent overloading of the gravity sand filters. These were rectified by polyelectrolyte dosing during clarification and redesign of the sand filters to accommodate low filtration velocities of 2,5 m/h.

The pilot-plant study was completed successfully in 1980 with the finalisation of the scientific and design reports on the project. The pilot-plant had demonstrated that the treatment sequence was able to provide closed loop recycling of wool/synthetic fibre dyehouse effluents at water recoveries of 85-95%.

Application

The process technology developed under this project has been used by the Romatex Group for the design of the first stage of a 1 500 m^3/h effluent treatment plant at their Uitenhage factory. The plant will be fully automated and will require minimal supervision. The plant is under construction at the present and will be commissioned in early 1983.

Wool scouring effluent treatment and reuse

The problem

South Africa is one of the major wool and mohair producing countries in the world with about 30 million wooled sheep. The greasy wool production in the 1981/82 season was 105 million kg and approximately half was scoured in South Africa. The wool scouring industry uses approximately 600 000 cubic metres of water per annum and its effluents have a pollution load of 8 million kg of grease, 5 million kg of suint and 12 million kg of solids (sand, clay, vegetable matter and fibre). This creates a substantial effluent problem which has received much attention both here and overseas.

Although many partial solutions to the wool scouring effluent problem have been suggested, no practicable solution has been developed. Until recently, the only effective treatment method for water reuse was evaporation. This has technical problems and is very expensive in both capital and operating expenses. The International Wool Secretariat has recognised that the disposal of wool scouring effluents is one of the major problems facing the industry. Because of increasing environmental pressures in the wool importing countries, it is expected that more and more wool will be scoured locally in the future. This will compound the already very difficult effluent discharge problems of the South African wool scourers.

A visual sample of the substantial effluent problem arising from the wool scouring industry.

Wool scouring effluents are considered to be one of the most highly polluting industrial wastewaters and contain 15-20 g/ℓ of grease, 10-15 g/ℓ of suint salts and 15-20 g/ℓ of suspended solids. Their disposal is very difficult and at present, they are lagooned for solar evaporation. Thus, it is very important to develop a practicable solution for wool scouring effluents to safeguard water quality and minimise the pollution impact.

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Pointers to management – wool scouring

- **95% recycle of desuinting effluent**
- **90 to 95% recycle of scouring effluent**
- **Water, heat energy and detergent savings are inherent in the system**
- **Solids control of the scouring bowls gives extra production time**
- **Volume of sludges to be disposed of is minimised**
- **Capital and running costs very favourable to alternative treatments**

Wool scouring is carried out in five or six bowl counter-current washers which operate under mild agitation conditions to minimise felting of the wool. Impurity removal is accomplished with detergent, builder and heat. Approximately 30-60% of the raw grease wool consists of impurities.

The treatment

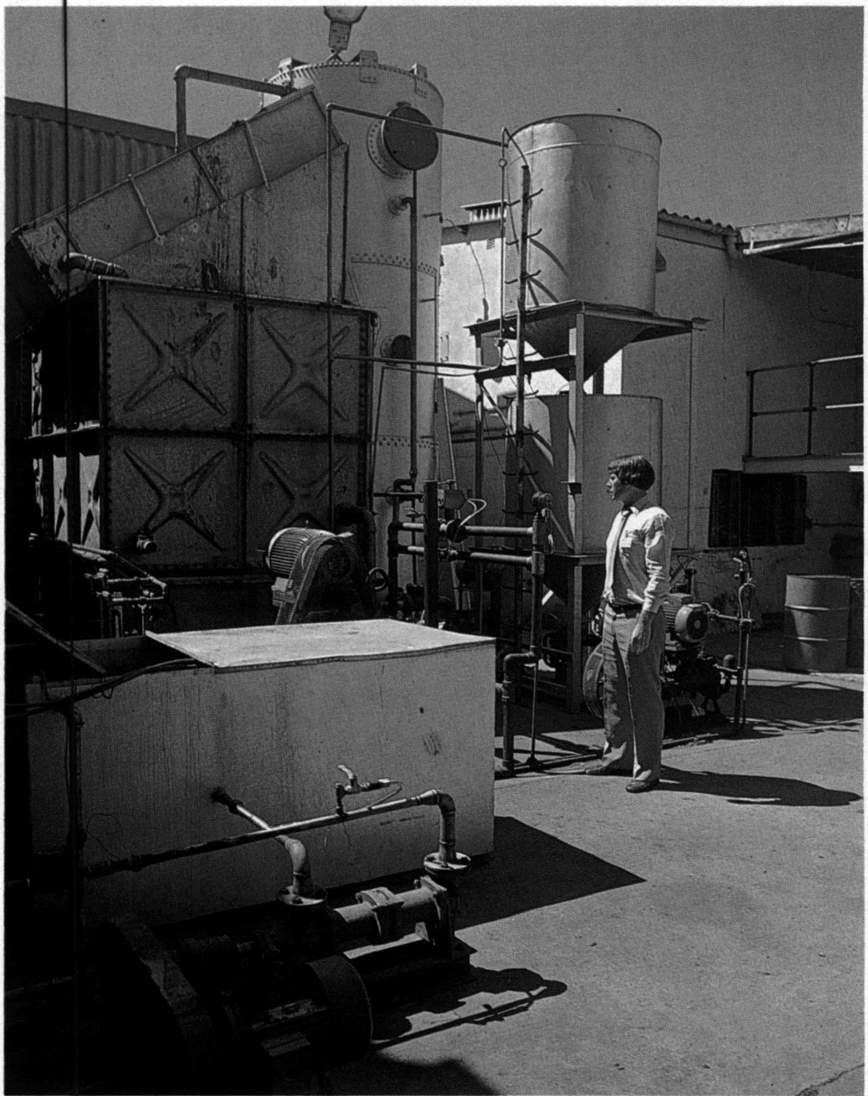
A new treatment/recycle system for wool scouring effluents has been developed by the Pollution Research Group and is under pilot plant testing at Gubb & Inggs Ltd., the country's largest wool scourer.

The system consists of three main parts:

- a modified scouring line to rationalise the water usage and effluent production into a low volume, cold desuinting effluent and a hot scouring effluent.
- treatment of the desuinting effluent for reuse by evaporation.
- treatment of the scouring effluent by dynamic membraned ultrafiltration for reuse in scouring.

Because there are only a limited number of effective treatment processes for the removal of suint salts and these are very costly, the new treatment system was designed to handle the suint salts in a rational manner by way of the low volume desuinting effluent. As some of the suint salts are carried over with the wool into the scouring section, suint build-up in the scouring recycle loop has also to be controlled. Dynamic membraned ultrafiltration, which has partial salt rejection characteristics, is used for this purpose. Normal ultrafiltration does not provide salt rejection.

The new treatment system combines the best features of two technologies: evaporation and ultrafiltration. **Evaporation** is used to treat the low volume, high concentration desuinting effluent and effects the main dissolved salts removal from the effluents. **Ultrafiltration** removes grease, suspended solids and the suint carry-over from the scouring effluent to produce reclaimed effluent for reuse. The combination of the two technologies results in a treatment cost which is substantially lower than that for evaporation of the total effluent.



Professor Ray Groves, research professor in the Dept of Chemical Engineering (University of Natal) and head of the Pollution Research Group pictured at the pilot plant for the treatment of wool scouring effluent at Messrs Gubb & Inggs Ltd, the largest wool scouring company in the Republic.

The treatment/recycle pilot plant is linked to the modified scouring line and consists of storage tanks, screens to remove fibre and the dynamic membraned ultrafiltration system. A membrane area of 25 m^2 is installed to handle the 1 500 ℓ/h of scouring effluent. The dynamic membranes are formed on 0,5 μm porous stainless steel tubes of 13 mm diameter. The effluent is processed at the scouring temperature of 60°C and is pumped around the membrane tubes at a velocity of 2 m/s. The grease, suspended solids and a proportion of the suint salts are ultrafiltered by the membrane and the permeated water is collected for return to the scouring line.

The results

During the project, the modified scouring line has produced over 1 million kgs of clean wool and the scoured wool quality has been within specification. Water usage has been significantly reduced by controlling the build-up of suspended solids in the bowls using side settling tanks thus allowing longer operating times between dumpings for cleaning purposes.

Pilot trials on the treatment of the desuinting effluent with a test evaporator have been successfully completed. Good quality condensate was produced for reuse in rinsing at water recovery levels of

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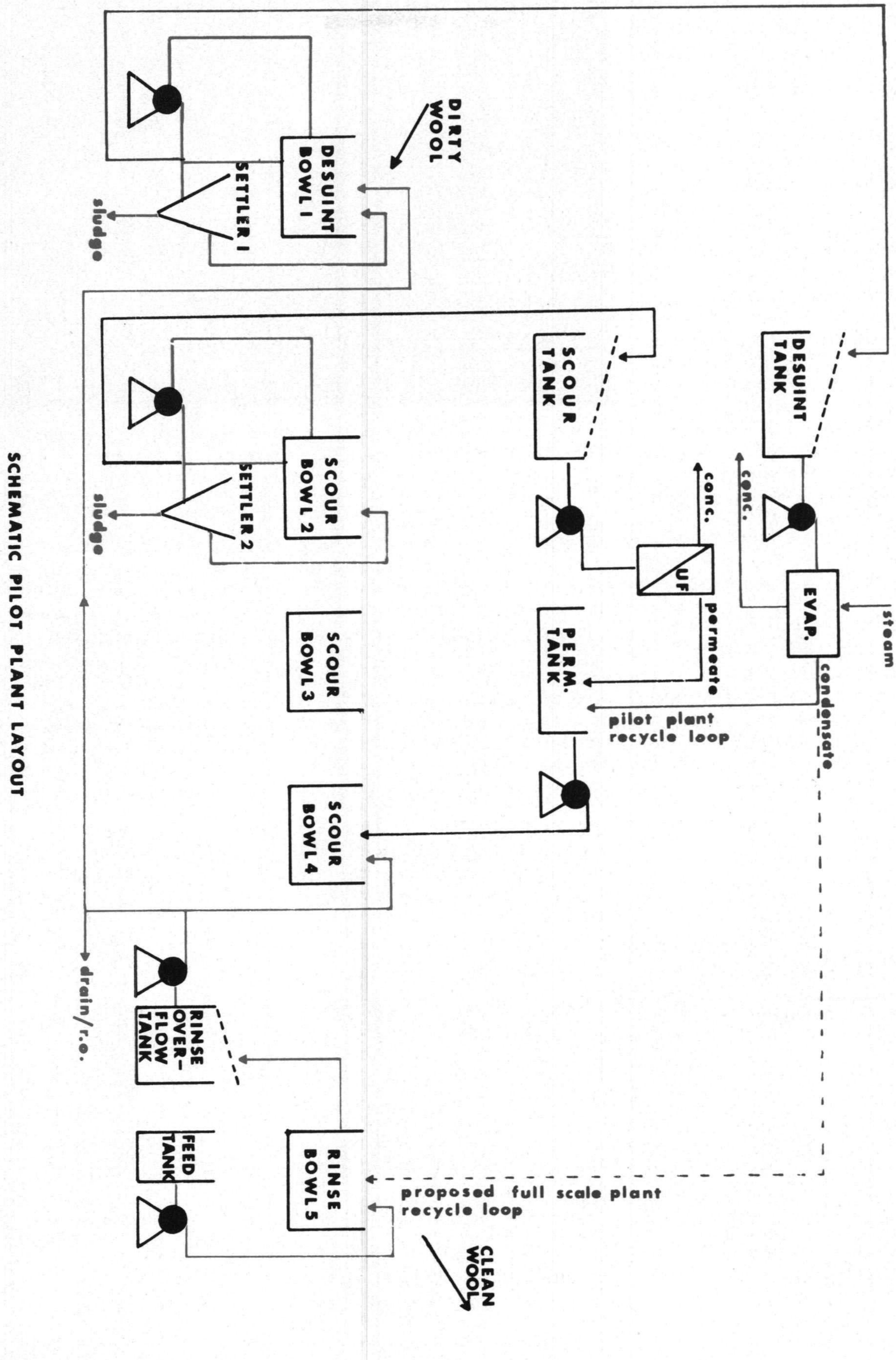


Schematic pilot plant lay-out: Messrs Gubb & Inggs, Uitenhage.

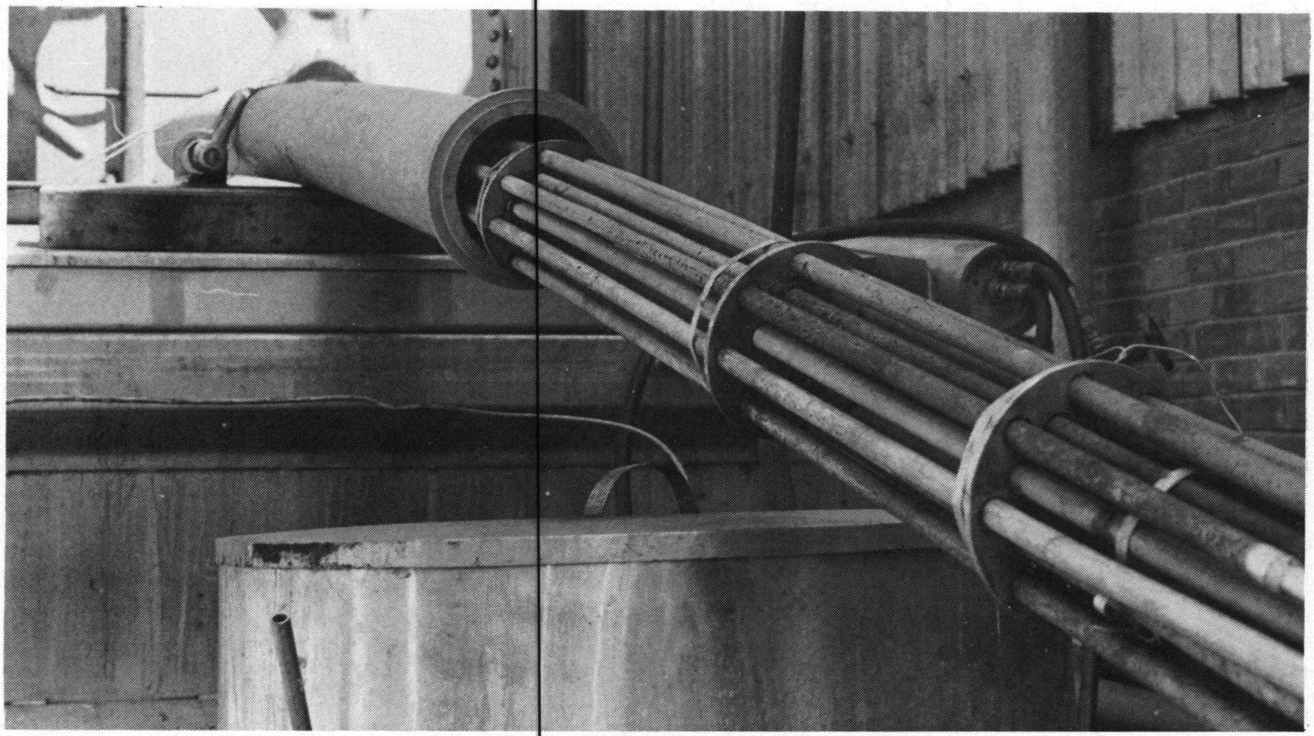
90-95%. Evaporation of the desuinting effluent gave little fouling of the heat transfer surfaces and this is in marked contrast to the evaporation of normal scouring effluents where cleaning is a major consideration.

The pilot-plant tubular ultrafiltration system uses dynamic membranes which have been specially developed for this application. Dynamic membrane technology has several advantages over conventional membrane technology for the processing of fouling and high strength effluents. These include wider pH and temperature limits; ability to handle suspended solids; *in situ* replacement of the membrane; a robust membrane and a long service life of the support tubes. A range of dynamic membranes have been developed by the Pollution Research Group and these cover the range from the ultrafiltration type with 0-10% salt rejection up to the reverse osmosis type with 95% salt rejection. In many cases the membrane can be tailored to provide optimum product rates and pollutant rejections for a specific application.

For desuinting wool scouring effluent the initial feed concentrations to the ultrafiltration plant have been about 25-40 g/ℓ of total solids, 10-20 g/ℓ grease and 7-10 g/ℓ suint. Grease and suspended solids removal by the membranes have been 100% under all operating conditions. The dissolved suint salt rejection depends on the type of dynamic membrane and can be varied from 40-85%. Membrane product rates are 30-80 ℓ/m^{2}h depending mainly on the type of membrane and the effluent concentrations. Over 90% of the treated effluent may be recycled before recycled water quality problems occur. Ultrafiltration pumping costs are approximately 6 kwh/m^3 of treated water.

This treatment process provides an effective and practicable solution to the wool scouring effluent problem. Major savings to the wool scourer are generated in terms of water recycle, heat energy savings, increased wool through-put and water savings.

A bird's eye view of the membrane development laboratory of the Pollution Research Group at the University of Natal.



A close-up view of the dynamic membrane unit used in the treatment of wool scouring effluent.

Sizing/desizing effluent treatment and reuse

The problem

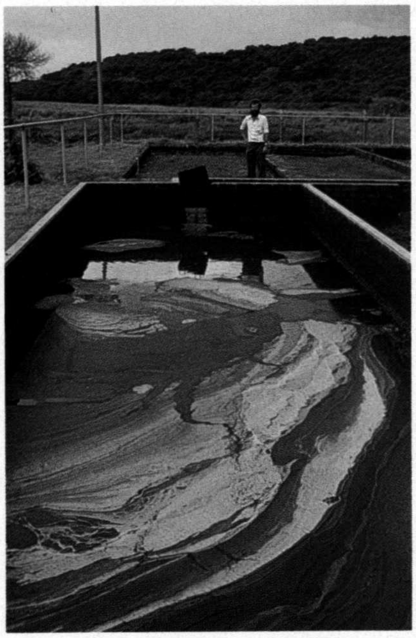
The cotton/synthetic fibre sector of the South African Textile Industry has over 50 mills using the sizing/desizing process. The effluent from this process alone constitutes an annual discharge of about 7 million kg of COD and 8 million kg of total solids. This has an organic pollution equivalent of about 250 000 people. At the mill level, the desizing effluent contributes 20-25% of the total organic pollution load and has concentrations of 4-20 g/ℓ of COD and total solids. Thus the treatment of the desizing effluent at point source would make a significant contribution to the reduction of the environmental impact of this type of textile mill.

The treatment

A three year pilot-plant investigation into the closed loop recycling of desizing effluents with the recovery of polymer sizes was initiated by the Water Research Commission in 1979.

Desizing effluents contain the sizing agent added to the fibres during sizing and some water soluble impurities from cotton. The main sizing agents in use are starch, polyacrylate and polyvinyl alcohol (PVA). Sizing of the individual warp threads with a protective film is necessary to resist the abrasive effects of the filling yarns as they are positioned by the shuttle action of the weaving loom. The size strengthens the yarn and reduces surface hairyness. Preliminary investigations showed that starch was unsuitable for recycle purposes because of the need for enzyme degradation prior to desizing. Polyacrylate sizes, although recoverable, were found to have poor weaving characteristics on reuse. Polyvinyl alcohol size was found to be recoverable and gave excellent sizing and weaving performance on reuse. Hence this sizing material was selected for the pilot-plant investigations.

The pilot plant was constructed at the D. Whitehead's factory of Tongaat Textiles and processed about 20% of the desizing effluent from the factory. The plant consisted of 100 m^2 of high temperature, spiral-wrap ultrafiltration modules arranged in ten banks of three modules each. Feed and product storage tanks were provided along with a prefiltration section to remove lint and suspended solids. The pilot plant was designed and constructed by the Pollution Research Group with the assistance of the factory. Operation of the plant was fully automatic.



The PRG's Mr Chris Buckley viewing the colourful but worrying effluent scene at a textile mill.

Long term weaving trials on both virgin and reclaimed PVA size were carried out by the factory. In total over 8 000 km of cloth were woven in these trials and this demonstrates the partnership basis under which the project was

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Pointers to management – sizing/desizing effluent

- **Water usage reduced to 1 to 2 ℓ/kg of cloth**
- **Effluent production minimal**
- **COD and total solids reductions are about 65% and 30% respectively in the wet processing section, and about 20% and 11% respectively for the total mill**
- **Closed-loop recycle system provides for water savings, heat energy savings, and improved mill effluent discharge**
- **Large sizing agent savings and reduced enzyme consumption are inherent in the treatment system**
- **Economics extremely favourable with capital paybacks of 0,5 to 1,6 years for the range of South African mills**
- **Full-scale treatment plant in planning stage**

The ultrafiltration pilot plant for the treatment of sizing/desizing effluent at Messrs D Whitehead Ltd at Tongaat in Natal.

organised. The cooperation of the factory was critical to the project, not only because of the actual cost of the cloth involved but also because a change of weaving efficiency of 1% represents an overheads cost of R290 per km. The conclusion from the trials was that a very high percentage of cloth types found in the industry were suitable for sizing and weaving with both virgin and recovered PVA size.

The basis of the treatment process is ultrafiltration, which separates the polymeric size from the water in the effluent. Removal of water from the effluent causes the reject from the ultrafiltration membranes to become more concentrated. For PVA size recovery, the concentration of PVA in the effluent is about 10 g/ℓ and for reuse in sizing, a PVA concentration of 90 g/ℓ is required. Hence, a concentration factor of 9 is needed and this represents a water recovery of about 85-90%. The ultrafiltration product is recycled back to the desizing washing range for reuse.

The results

Investigations into the efficiency of desizing washing showed that considerable variation exists in the industry, ranging from 5-25 ℓ/kg of cloth. For fairly efficient countercurrent washers, PVA size removals from the cloth of over 95% with hot water were achievable at water usages of about 5 ℓ/kg. The PVA size left on the cloth after desizing has not caused any problems in down stream processing.

Prefiltration of the effluent to remove lint was found to be the most difficult technical aspect of the project. After considerable development work, a treatment sequence consisting of screening, back-washable candle filtration and cartridge filtration was found to be suitable and cost effective.

The results of operating the ultrafiltration pilot plant for over two years showed that the membrane flux (volume of product produced per unit membrane area per unit time) was mainly dependent on the initial PVA concentration, the concentration factor needed, temperature, degree of membrane fouling, pressure and reject flow rate. For a given factory duty, the desizing water usage and size add-on determine the initial PVA concentration and the concentration factor needed. The pilot-plant results indicated that the membranes should be operated at their inlet pressure and temperature limits. Thus the degree of fouling and the reject flow rate are the operating parameters that may be optimised.

A mathematical model describing the hydrodynamics of the membrane module was developed for this purpose. A more general model, suitable for the design and operation of full-scale treatment plants, has also been developed and verified on the pilot-plant operating data.

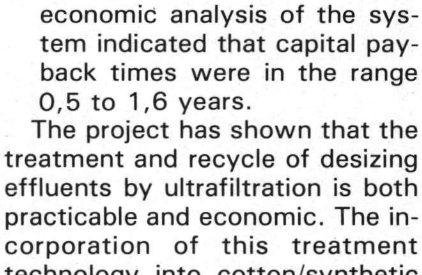
A detailed technical manual on the treatment and recycle of textile desizing effluents was completed in 1982. The advantages and benefits of this treatment/recycle system are:

- water usage in sizing/desizing is reduced to 1-2 ℓ/kg of cloth, which is the moisture carry-over of the cloth leaving desizing.
- effluent production is minimal. Desizing COD and total solids loads are reduced by 84 g/kg of cloth and 90 g/kg respectively. This represents reductions in COD and total solids in the wet preparation section of about 65% and 31% respectively and for the total mill of about 20% and 11% respectively.
- water savings, decrease in the effluent discharge costs and heat energy savings owing to the closed-loop recycle system.
- large chemical savings in terms of recycled size and a significantly reduced enzyme consumption are inherent to the treatment system. A detailed economic analysis of the system indicated that capital payback times were in the range 0,5 to 1,6 years.

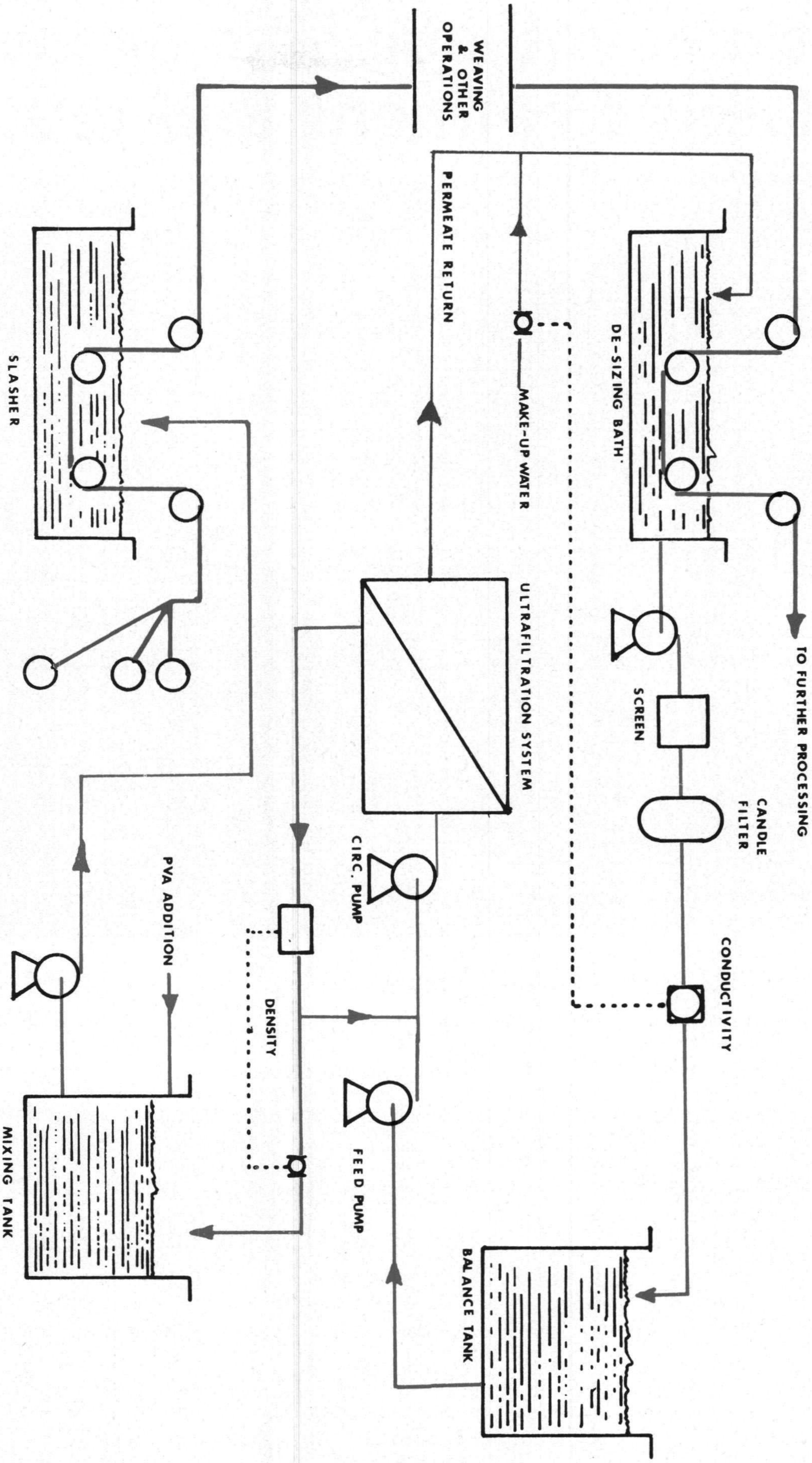
The project has shown that the treatment and recycle of desizing effluents by ultrafiltration is both practicable and economic. The incorporation of this treatment technology into cotton/synthetic fibre textile mills will have a significant impact on effluent discharges and will result in major cost savings.

Application

One large textile mill in South Africa has decided to construct a full-scale ultrafiltration treatment plant and several others are assessing at present the system for their mills.



A conventional ultrafiltration membrane used for size recovery.



Flow schematic for textile sizing recovery by ultrafiltration.

Cotton/synthetic fibre dyehouse effluent treatment and reuse

Messrs K Treffry-Goatley (left), C Buckley and R Groves of the Pollution Research Group discussing pilot plant performance at Ninian & Lester's in Durban. A glimpse of the pilot plant's abilities is to be seen on page 1 of this issue.

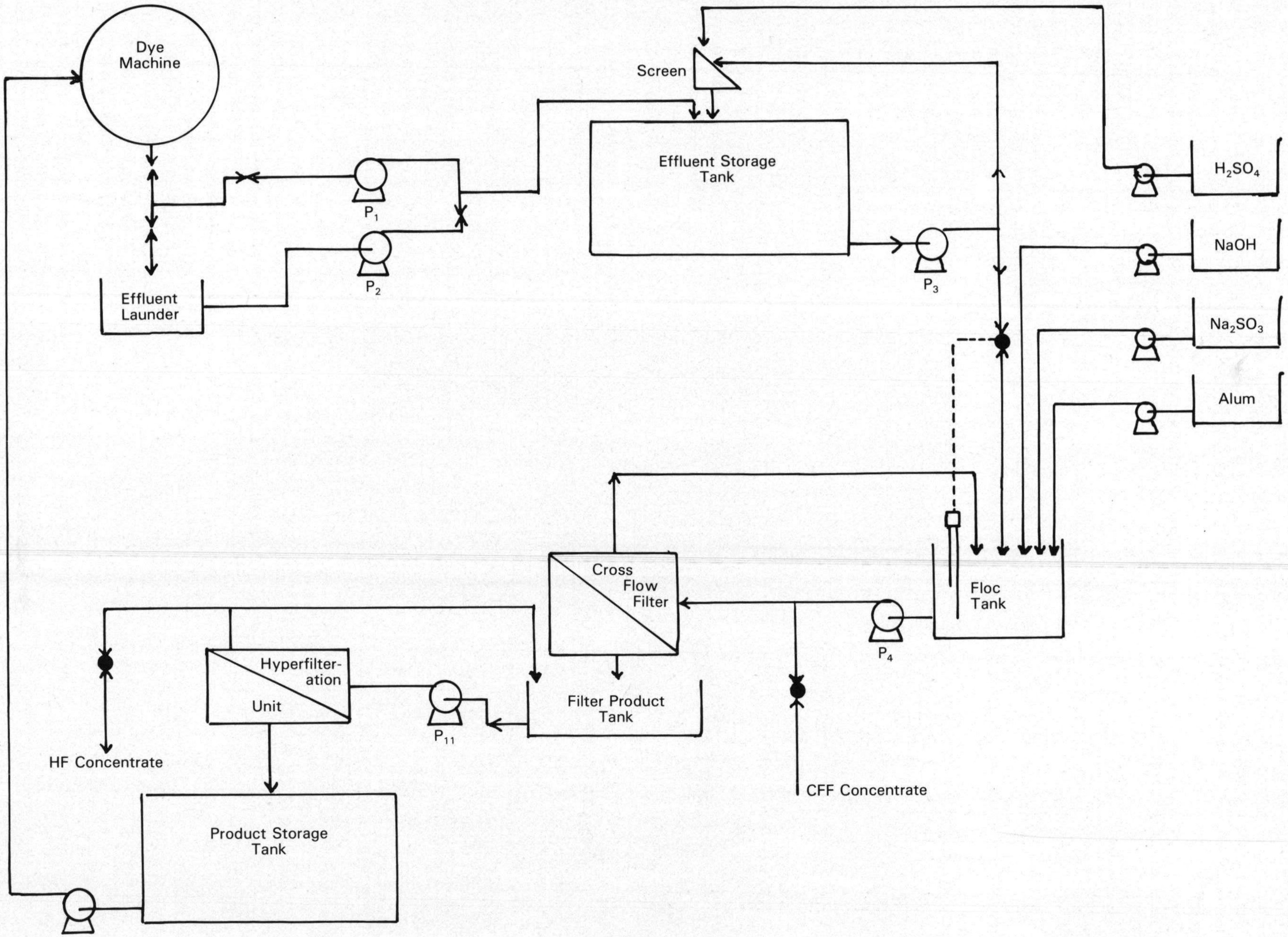
The problem

Dyeing and printing effluents are discharged by most textile mills in the cotton sector of the industry. The fibres dyed are cotton, viscose, polyester and nylon including blends in the form of knitted and woven cloth and in the yarn state.

(Text to page 14)

Pointers to management – cotton/synthetic dyehouse effluent

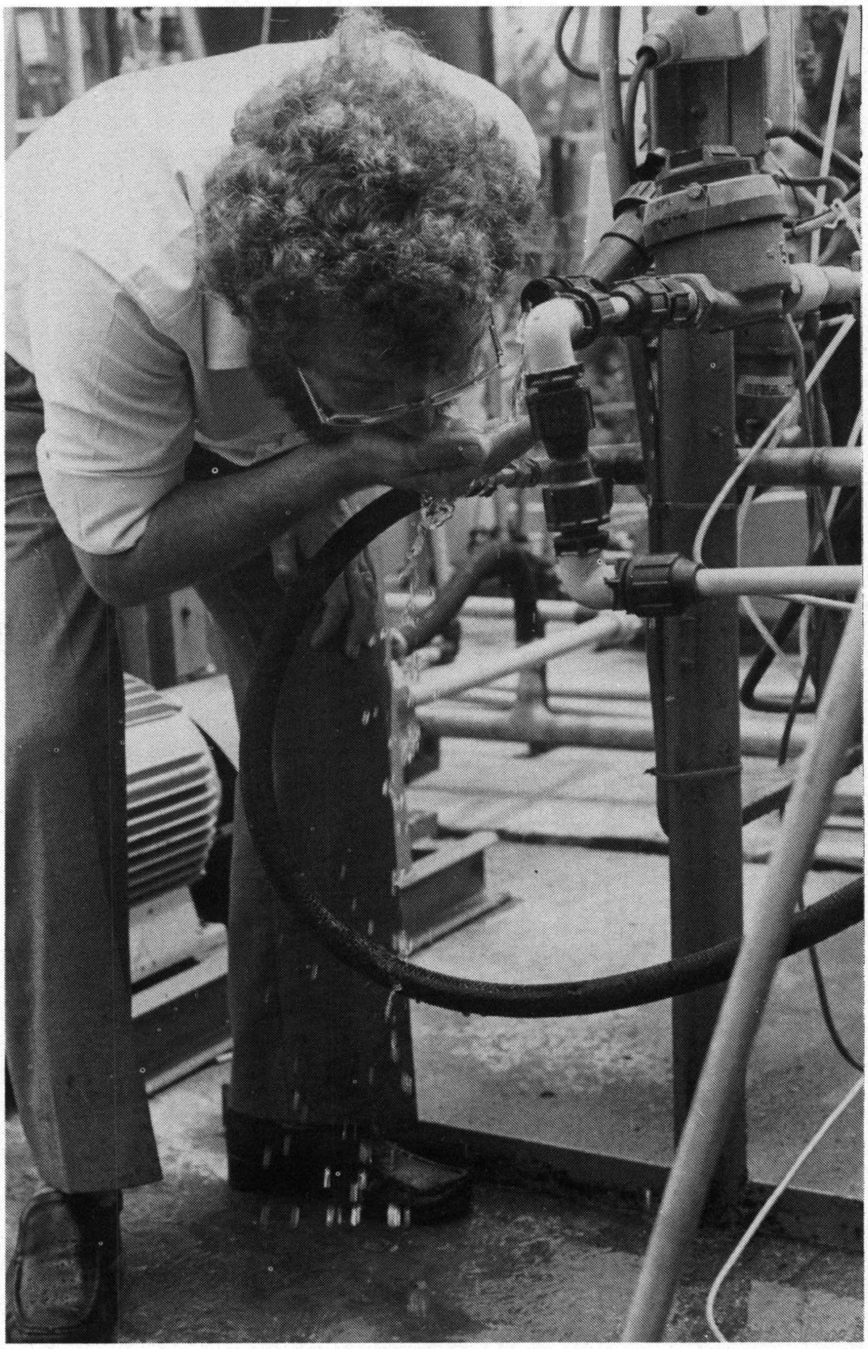
- **Suitable for all types of cotton, viscose, polyester and nylon dyeing wastewaters**
- **85 to 95% water recycle**
- **Water quality is excellent, exceeding most mains water standards**
- **Printing effluent may be treated for reuse**
- **Dyeing trials with reclaimed water were highly successful**
- **Full-scale treatment plant in planning stage**



Pilot plant lay-out: closed-loop treatment and recycle.

Many different dyeing recipes are used and the effluents contain both soluble and colloidal colour, alkali, salts, acetic acid, detergents, wetting agents, levelling agents and antifoams. Other contaminants that may be present include scouring agents, oils and greases, softeners and stripping chemicals. The exact nature of the effluent is thus highly dependent on the type of processing being carried out by a particular factory.

Because of the diversity of cotton/synthetic fibre dyehouse effluents, biological and physical-chemical treatment methods are only partially effective and do not control the mineral salt loads. For this reason, hyperfiltration (reverse osmosis) has been investigated as the primary treatment method as this membrane technology is capable of removing the three major constituents: salts, organics and colour.



The proof of the pudding . . . Mr Chris Buckley sampling the permeate from the pilot plant at Ninian & Lester's.

The treatment

The Water Research Commission approved a three year pilot-plant project in 1980 on the treatment of cotton/synthetic fibre dyehouse effluents with water reuse. Because of the complexity of these effluents, the research and development programme was carefully formulated and included investigations on the treatment of

- colloidal dyestuff effluents from polyester dyeing by microfiltration.
- cotton type dyeing effluents by hyperfiltration.
- mixed cotton/synthetic fibre dyehouse effluents by microfiltration and hyperfiltration.
- printing effluents by flocculation.
- hot effluents from continuous dyeing and printing by dynamic membrane hyperfiltration.

The results

The 30 m^3/d pilot-plant was constructed at the Ninian and Lester factory at Pinetown and has operated on the dyehouse effluents for two years. The hyperfiltration unit consists of both brackish water and seawater type spiral-wrap membranes which are capable of operation at 45°C and in the pH range 3-10. Because of the presence of colloidal particles in the mixed effluent, it is necessary to remove these prior to hyperfiltration and alum coagulation followed by cross-flow microfiltration was used for this purpose. The hyperfiltration configuration allows high water recoveries (up to 95%) with the final concentrate reaching up to 70 g/ℓ of total solids.

The microfiltration pretreatment unit has consistently removed suspended solids and colloidal dyestuffs so as to provide a feed suitable for the spiral-wrap membrane hyperfiltration. Constant flux performance on a variety of different dyehouse wastewaters was obtained by regular cleaning at two-weekly intervals.

The hyperfiltration unit has operated at water recoveries in the range 90-95%. Membrane fouling, which caused loss of both flux and rejection performance, has been problematic but was controlled by regular cleaning of the membranes with the recommended cleaning solutions. Membrane rejections of total dissolved solids, organics and colour have been in the high ninety percents. The average specification of the recycled water back to the dyehouse has been excellent with values of 60 mg/ℓ total dissolved solids; 0,07 mS/cm conductivity; 15 mg/ℓ of sodium; 11 mg/ℓ of total organic carbon and 21 ADMI colour units. This quality was better in general than the normal process water. From the pilot-plant investigations it is anticipated that membrane life on dyehouse effluents will be three years or longer.

The reclaimed water was recycled back to the dyehouse and was used routinely for production dyeing. All dyeing results to date have been very good and over 50 000 kg of fibre have been dyed. The full range of dyeing formulations has been tested varying from optical bleaching through pale shades to black using from 0,02 to 50 g of dye per kg of fabric.

Projects have also been carried out on the treatment of printing effluents by alum flocculation and filtration and on the treatment of hot continuous dyeing and printing effluents by dynamic membraned hyperfiltration. The former project investigations concluded that the treated printing effluent was suitable for recycling back to the printing section for screen washing or that the treatment process was suitable as a pretreatment prior to hyperfiltration. The dynamic membraned hyperfiltration project is still ongoing in cooperation with a local textile mill and the results to date are very encouraging. The effluent is treated at 90°C and good membrane flux and rejection performance have been obtained.

The project investigations have shown that it is possible to treat the cotton/synthetic fibre dyehouse effluents either singly or in combinations to factory water reuse standard. Combinations of the developed treatment processes will allow selection of the best treatment/recycle system to be installed at a particular factory to suit their needs.

Application

Although the project has only recently been finished, one factory has decided to proceed with a full-scale hyperfiltration plant and several others are assessing the possibility.

Cotton scouring

Research into the treatment of cotton scouring effluents will commence during 1983.

REPORTS ON TEXTILE EFFLUENT PROJECTS

1. **Wool/Synthetic Fibre Dyehouse Effluent Treatment – 6 Technical reports available plus final report.**
2. **Wool Scouring Effluent Treatment – 14 Technical reports available.**
3. **Sizing/Desizing Effluent Treatment – 9 Technical reports and final technical manual available.**
4. **Cotton/Synthetic Fibre Dyehouse Effluent Treatment – 14 Technical reports available.**
5. **Textile Industry Survey Reports – 5 Technical reports available.**
6. **Printing Effluent Treatment – 2 Technical reports available.**

PUBLISHED PAPERS

24 at conferences or published in international journals, of which the following selection may be of interest:

GROVES, GR (1976) Ultrafiltration of textile desizing effluents. *Proceedings of SA Inst Chem Engrs. 2nd National Meeting.* Johannesburg, August 1976.

GROVES, GR (1976) Ultrafiltration of industrial effluents. Paper presented at NIWR/IWPC Symposium on Selected Studies on Demineralisation. Pretoria, October 1976.

GROVES, GR, BUCKLEY, CA and DALTON, GL (1978) Textile size and water recovery by means of ultrafiltration. *Prog. Water Technol. 10*(1/2) 469.

GROVES, GR (1979) Dynamic membrane ultrafiltration of desuinted wool scouring effluent. Paper presented at the International Conference on the Disposal of Wool Scouring Effluents, CSIRO, Geelong, Australia, 24-26 September 1979.

GROVES, GR, BUCKLEY, CA and TURNBULL, RH (1979) Closed loop recycle systems for textile effluents. *J Water Pollut Control Fed 51* (3) 499-517.

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GROVES, GR and BUCKLEY, CA (1980) Membrane processes for desalination and recovery of chemicals from industrial effluents. Paper presented at the Water Research Commission/NIWR Workshop on Desalination, Pretoria, 14-15 Aug 1980.

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FLEMMER, RLC, BUCKLEY, CA and GROVES, GR (1982) An analysis of the performance of a spiral-wound ultrafiltration membrane with a turbulence-promoting net. *Desalination 41 (1),* 25-33.

BUCKLEY, CA, TOWNSEND, RB, and GROVES, GR (1982) Performance of an ultrafiltration pilot plant for the closed-loop recycling of textile desizing effluents. *International Association on Water Pollution Research.* 11th Conference, Cape Town, 29 March – 2 April 1982.

BUCKLEY, CA and GROVES, GR (1982) Treatment of desizing effluents for recovery and reuse of polymer sizes – pilot plant performance and economics. *Proceedings of Symposium on New Technologies for Cotton:* Textile Institute/SAWTRI, 26-28 July 1982; 483-504.

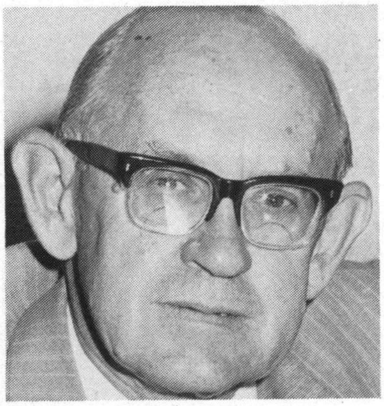
THE POLLUTION RESEARCH GROUP AND THE WRC

The Pollution Research Group of the University of Natal was founded in 1972 by Professors Ted Woodburn and Ferdie de Wilde with support from AECI and the Water Research Commission. Professor Ray Groves was appointed in 1974 to carry out the Commission-sponsored projects. As a group they have carried out over 20 detailed industrial effluent investigations and are recognised internationally as a major contributor to the research and application of advanced industrial effluent treatment and reuse. The project leaders on the projects sponsored by the Water Research Commission were R.H. Turnbull, C.A Buckly, C.D. MacMillan and K.H. Treffry-Goatley.

The projects have been carried out on a partnership basis with industry and major contributions to the research programmes have been made by the associated industrial concerns.

The Water Research Commission is a statutory body established in 1971 by Act of Parliament. The objectives of the Commission are briefly to coordinate, promote, encourage or cause to be undertaken, research on the occurrence, preservation, conservation, utilization, control, supply, distribution, purification, pollution or reclamation of water; also research on the use of water for agricultural, industrial and urban purposes. On this page the principals of the WRC are introduced, with Prof Groves.

Dr MR Henzen, chairman and chief executive officer of the Water Research Commission.

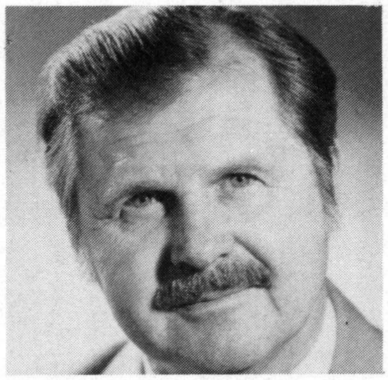


Prof PJC Vorster, chief adviser at the WRC.

Mr PE Odendaal, chief adviser at the WRC.

Prof GR Groves, research professor at University of Natal and head of the Pollution Research Group.

Mr DS van der Merwe, chief adviser at the WRC.



Dr OO Hart, senior adviser for industrial water and effluent management.

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