WATER RESEARCH COMMISSION PROJECT NO. 201

THE TREATMENT OF INORGANIC BRINES AND CONCENTRATES

APPENDIX 13

Visit to ISCOR Newcastle

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1 INTRODUCTION

The ISCOR works at Newcastle is situated between the Buffalo and Ingagane Rivers. The raw products entering the plant include oil, coal, iron ore, lime, fluxing chemicals, water, air and other miscellaneous chemicals.

Iron and steel alloys are the major product formed, with 80% of the total production being exported. By-products produced include high quality fuel, ammonium sulphate, sulphuric acid, tar and oil. In addition, liquid effluents, ash and slag are discharged as waste from the plant.

2 PROCESS DESCRIPTION

The steel manufacturing process starts with the crushing of coal such that 78 to 85% of the fragments are smaller than 3 mm in diameter. The coal is then conveyed into the coke ovens, where the volatiles (approximately 30% of the coal) are removed by heating the coal in the absence of air. There are two coke producing batteries at ISCOR, Newcastle, each of which consists of 100 ovens, with separate coke handling and gas purification systems. Each battery has a maximum coking capacity of 8 000 ton coal/d. Coking temperatures of 1 320 to 1 350°C are employed.

The coke, in combination with iron ore (Fe_2O_3 with some Fe_3O_4), air and carbon monoxide, is used to produce steel. The coke is fed either directly to the blast furnace or, in the case where there is a need to increase the pellet size, to the sinter plant first. The molten iron, containing 4% carbon, silica and sulphur, is separated from the slag and transported by rail to the basic oxygen furnaces. If the temperature of the molten metal is below 1 400°C it is preheated in an induction furnace before entering the basic oxygen furnace.

The charge to the basic oxygen furnace consists of 90% hot metal, 10% scrap metal and fluxing material (sodium carbonate and sodium fluorsilicate). Oxygen gas is blown into the basic oxygen furnaces to convert the impurities into oxides (SiO_2, CO, CO_2, SO_2) which are removed in the slag. The percentage removal of these impurities determines the quality of the final product. The alloys are added to the steel before casting. A wide range of steel qualities, ranging from 0,08 to 0,87% carbon, is produced.

The basic oxygen furnace at Newcastle consists of three converters, each with a capacity of 144 m^3 and with a nominal heat size of 150 tons. The annual capacity is 2 800 000 tons. Oxygen gas is blown in at a rate of 30 000 m^3/h and the process is limited by the availability of hot metal and the continuous casting capacity. The processing variables within the basic oxygen furnace (charge and flux calculations, oxygen blow volume, lance height etc.) are controlled by computer.

The total production of the blast oxygen furnace is continuously cast into blooms from 170 ton casting ladles. There are three casting machines, each with a maximum capacity of 150 000 tons/month and casting 6 blooms. The blooms measure 315 mm x 205 mm (on two machines) and 315 mm x 315 mm (on the third). A maximum of two machines are operated at any one time. The casting speed is 1 to 1,2 m/min and the casting time per 170 ton ladle is 50 to 55 min, which coincides with the cycle time of the basic oxygen furnace.

The blooms are weighed on an electronic scale and either conveyed to the cooling transfer bank for storage/reconditioning or to the reheating furnace (which are gas or tar fired with a capacity of 150 ton/h). The blooms are cut into billets, of which 1,6 million ton/a are produced. The size of the billets range up to 17 m depending on the type of mill in which it is to be further processed. There are three types of mills: bar, rod and medium.

3 GAS PURIFICATION AND BIPRODUCT MANUFACTURE

The volatile matter in the coal is distilled as a multi-component gas during coking. The gas is purified by various scrubbing processes to enable the production of a low benzol and sulphur gas for use as fuel. In addition, ammonia and hydrogen sulphide are stripped from the stream and used for processing to sulphuric acid and ammonium sulphate. Naphthalene and tar are also produced.

The conversion of waste coking gases to fuel has enabled the LP gas usage at the plant to be decreased by R5 000 000/a. The purified coke oven gas is stored in a 150 000 m^3 container.

Off-gas from the basic oxygen furnace is stored in an 80 000 m^3 holder. This off-gas is used as low quality fuel and has a calorific value six times less than that from the coking gas.

4 WATER USAGE AND TREATMENT

The works withdraw 800 to 900 m^3/h of water from the Chelmsford Dam, which is situated on the Ingagane River. This volume is only a small portion (2,1%) of the total process water circulating within the works (42 000 m^3/h). The water cost is 14 c/m^3.

All the water entering the works is passed through the main purification plant where it is flocculated using alum. After pH adjustment with lime (1 000 kg/d) this water is either filtered and chlorinated to produce drinking water or it is settled to produce industrial grade water for use in the cooling tower circuits and other processes.

The drinking water is further processed in:

(i) one of the three softeners which are regenerated using sodium chloride (750 kg/d). This water is either used directly in processing in the coke ovens and furnaces or is treated in:

(ii) the demineralisation unit. The softened water is treated at a rate of 140 m^3/h in the demineralisation plant which consists of continuous and batch units and a mixed bed polisher. Sodium hydroxide (3 ton/d at 45%) and sulphuric acid (3 ton/d at 98%) are used to regenerate the plant. The batch units are demineralised every six hours and each line consumes approximately 100 m^3 of rinse water per regeneration cycle. The demineralised water is fed to the boilers, of which there are two low pressure and two high pressure units.

The waste regeneration chemicals (55 to 60 m^3/h) pass through a 60 m^3 buffer tank after pH correction and are concentrated in a seeded slurry ($CaSO_4$) falling film evaporator equipped with titanium tubes. The condensate (45 m^3/h) is recycled to the head of the demineralisation unit. When the feed to the evaporator is below 60 m^3/h, drinking water make-up is added such that the evaporator functions continuously.

The evaporator consists of four effects. After the fourth effect the slurry is separated for:

- dosing/seeding the incoming feed or for
- passage through the crystalliser, from which the slurry is transported to the evaporation dams by tanker.

Limited scaling occurs and is controlled by:

- the addition of a phosphate-acrylate scale prevention modifier which prevents lump formation and hence nozzle blockage. Attempts are made to control the concentration of this modifier at 30 ppm, although spot samples collected on a weekly basis have contained as much as 300 ppm;
- cleaning using water flushes;
- acid cleaning every two to six months.

5 EFFLUENT STRATEGY

The approach taken by the works personnel to combat pollution includes (1):

(i) control at source;

(ii) segregation of different quality discharges to minimise the volume requiring treatment;

(iii) reuse of poor quality water for quenching coke and slag;

(iv) application of the most economic handling which is acceptable to the Department of Water Affairs.

The effluents are segregated into four streams:

(i) recoverable water, which after clarification and oil removal in the works treatment plant is of sufficient quality for discharge to the Ingagane River. All water discharged from the works to this river must comply with the general standards of the Water Act. The flow of recoverable effluents is approximately 220 m^3/h;

(ii) irrigation water in which the nitrogen and phenol concentrations do not comply with the quality standards for general discharge. A 5-year extension of the irrigation permit has been issued by the Department of Water Affairs on condition that immediate reclamation of the soil is carried out. To this end ISCOR have engaged consultants in the soil science and agricultural engineering spheres. An alternative process must be implemented by 1994. The target flow of irrigation water is 50 m^3/h. However, the actual flow is as high as 80 m^3/h.

(iii) evaporation water whose TDS and SS concentrations are too high for irrigation. This water is dumped into one of four disused dams and dam space is rapidly decreasing.

(iv) storm water which should not be contaminated with industrial chemicals and can thus be discharged to the river. Storm water flow from the coke ovens, basic oxygen furnace area and mills is approximately 45 to 50 m^3/h.

6 RECOVERABLE WATER

To maintain the quality of the recoverable water within the limits specified by the Department of Water Affairs, ISCOR need to:

(i) control the fats and oils in the river discharge (first priority);

(ii) effectively remove oil at source;

(iii) negotiate with the Department of Water Affairs to ease the oil standard from 2,5 mg/ℓ to 6 mg/ℓ and the phenol standard from 0,1 mg/ℓ to 0,2 mg/ℓ.

The recoverable water has its origin in the cooling water circuit, the floor washings and softener regeneration. Two streams are combined to form the final water for treatment: the North and West streams. The important parameters are pH, OA, TDS, SS, soaps and oils, ammonia, fluoride, phenol, cyanide and COD.

The component and final streams are monitored every 2 hours with respect to ammonia and pH. A composite sample is analysed in full daily and the final composite records are submitted to the Department of Water Affairs each month.

Tables 1, 2 and 3 (1) give the analysis of the North, West and final recoverable water for the six month period 1/7/85 to 31/12/85. These tables show that various samples over the period exceeded pH, TDS, fats and oils and phenol limits. The averages were within the limits except for TDS and fats and oils. The average fats and oils were 88% greater than the standard of 2,5 mg/ℓ. The oils in the effluent came mainly from the workshop area. The phenols exceeded the limit 41% of the time and the TDS 80% of the time.

Comparison of Table 3 with more recent figures (Appendix 1) for periods during 1987 and 1988 indicate that:

TABLE 1 : Analysis of Western Recoverable Effluent for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	Variation %	% Outside standard
pH	5,5 - 9,5	8,6	1,8	20	36
TDS	500 + 277	897	473	53	50
Fats and oils	2,5	3,4	3,9	117	48
Free NH_3	10	0,51	0,70	138	0
F	1,0	0,67	0,68	100	13
Phenol	0,1	0,06	0,10	161	16
CN	0,5	0,04	0,10	233	1

TABLE 2 : Analysis of Northern Recoverable Effluent for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	Variation %	% Outside standard
pH	5,5 - 9,5	9,0	1,2	13	28
TDS	500 + 277	968	557	58	60
Fats and oils	2,5	4,9	5,1	103	63
Free NH_3	10	0,67	1,12	169	0
F	1,0	1,8	1,6	85	66
Phenol	0,1	1,12	0,13	112	48
CN	0,5	0,09	0,22	236	2

TABLE 3 : Analysis of Final Recoverable Effluent to the Ingagane River to 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	Variation %	% Outside standard
pH	5,5 - 9,5	7,6	1,8	24	23
OA	10	5,3	3,2	60	7
TDS	500 + 277	961	285	31	80
SS	25	13,9	7,8	56	8
Fats and oils	2,5	4,7	7,5	160	41
N	10	1,65	1,51	92	0
F	1,0	0,76	0,98	129	17
Phenol	0,1	0,10	0,11	110	41
CN	0,5	0,09	0,12	133	1
COD	75	18,2	9,2	51	1

(i) the percentage of samples which were outside the General Standard limit had decreased as follows:

from 23% to 7,5% for pH.
from 8% to 6,6% for SS.
from 17% to 5,5% for F.

(ii) there was an increase in the percentage of samples which were outside the General Standard limit with respect to various constituents as follows:

from 1% to 4,8% for CN.
from 41% to 56,4% for fats and oils.

(iii) the number of samples exceeding the phenol limit remained constant but at the high level of 41%.

The final recoverable water is treated in the works plant prior to discharge. Oil and gross particles are removed in the sumps before alum dosing, flocculation and clarification. The clarified liquor is pumped to the Ingagane River unless its quality is below the standard, in which case it is pumped to irrigation.

The main sources of recoverable effluents are as follows:

6.1 Northern Recoverable Effluents

This stream includes:

(i) waste chemicals from the softeners in the continuous casting area which consists mainly of sodium chloride, calcium and magnesium. The highly saline wastes (i.e. the first 10 min flow of regenerant) are pumped to irrigation and the remaining waste is combined with the other recoverable effluents.

(ii) cooling tower blowdown from the milling section which contains oils, SS and TDS.

(iii) cooling tower blowdown from the oxygen plant which is particularly high in TDS.

(iv) sidestream filter backwash and cooling tower blowdown from the compressed air plant. This stream contains SS and TDS.

(v) process washwater and centrifuge waste both containing mainly particulate matter from the mains water purification system.

6.2 Western Recoverable Effluents

This stream includes:

(i) effluents from the coke-oven and by-products area such as cooling tower blow-down, pump sump overflow, sand filter backwash. This stream is a source of ammonia, SS and TDS;

(ii) blowdown from the closed water system on blast furnace N5 which contains phosphate and small amounts of organic wastes;

(iii) regenerant chemicals from the demineralisation unit. Recently this stream has been diverted to the evaporator to reduce the TDS content of the recoverable effluent.

(iv) cooling water from the bearings of the blower in the boiler area which is generally uncontaminated. Other streams from the boiler area include cooling tower blowdown from the alternator circuit (high in TDS) and sand filter backwash (high in SS).

(v) discharge from the workshop and oil-change area which is loaded with oils and detergents.

Table 4 (1) summarises the sources of pollution in the recoverable effluent.

TABLE 4 : Possible Sources of Pollution in Recoverable Effluent

Source	Type of Pollution								
	P	Na	Phenol	CN	Low pH	N	Oils	SS	TDS
Continuous casting	X	X							X
Mills							X	X	X
Oxygen plant									X
High pressure air plant								X	X
Mains water purification								X	
Coke ovens			X						X
By-products			X		X	X		X	X
Blast furnace	X	X		X		X			X
Demin. unit		X			X				X
Boilerhouse		X							
Workshops							X		

7 IRRIGATION EFFLUENT

It is intended that:

(i) pollution in this effluent will be reduced by isolating the slag heaps and controlling run-off;

(ii) irrigated land will be upgraded;

(iii) blower effluent from the dust collectors in the steel plant will be segregated and transferred to the storm water drain.

Approximately 1,6 Mℓ is irrigated daily. This volume is 67% lower than the original permit allowing 4,8 Mℓ/day to be irrigated. This is mainly a result of two coke ovens being taken off line. In addition, modifications to the by-products plant have enabled the reuse of low quality water in the quench towers. The irrigation effluent passes through the works effluent system to dam 5 which is interconnected to the six irrigation effluent dams. From dam 10 the effluent is irrigated through three distribution points.

The irrigation effluent originates mainly in the gas purification system near the coke ovens. Smaller contributions come from the blast furnace gas purification system, boilers, gas holders, gas and water seals, steel plant, burners, blast furnace slag leachate and benzol and sulphur processing. The main contaminants are nitrogen, phenols, salts and other components whose concentrations are too high to handle at the works treatment plant for discharge to the river.

Table 5 gives the analysis of the irrigation water over the period 1/7/1985 to 31/12/1985.

TABLE 5 : Analysis of Irrigation Effluent as Sampled in Dam 10 for the period 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Average	Standard deviation	% Variation
Volume (m^3/h)	65	5	-
pH	9,1	0,5	6
OA	30,1	17,0	57
SS	2 208	348	16
Conductivity (µS/cm)	3 154	497	16
Na	740	176	24
N	4,5	3,5	78
F	20,4	13,1	64
Phenol	0,28	0,16	57
CN	0,23	0,41	178
COD	94,9	33,1	35

Its pH is particularly high and it contains high concentrations of fluoride from the steel process and of sodium due to slag heap run-off. Capture furrows installed around the slag heaps will ease the situation.

Comparison of the 1985 figures with more recent figures reported in Appendix 1 (1987-1988) indicates that the average concentrations in the irrigation water have decreased as follows:

pH : from 9,1 to 8,2.
OA : from 30 to 20 mg/ℓ.
CN : from 0,23 to 0,03 mg/ℓ.

There has been no improvement in nitrogen discharge levels and the average fluoride and phenol levels have increased. During the period July 1987 to June 1988 less than 10% of the samples fell within the goal standard range for fluoride, conductivity, sodium, OA and phenol.

There is no proof at present that the pollution in the irrigation water is effecting the quality of the water in the surrounding rivers. Analysis of soil samples in the irrigated area show certain points of high salinity, which is expected to be rectified with the implementation of annual top soil reworking.

The composition of the irrigation water must comply with permit 669B of January 1980 which states that:

(i) a total amount of 584 to 1 000 mm of effluent may be irrigated;

(ii) the N limit on the irrigated ground is 457 to 1 000 kg/ha.a.

(iii) the area limit of the irrigated ground is 175 to 300 ha.

The Ingagane and Buffalo Rivers are sampled weekly (above and below the irrigated land) so that any effect on the river quality may be determined. The important analyses include pH, conductivity, Na, Chlorine, COD and free ammonia and a monthly report is submitted to the Department of Water Affairs.

In addition, daily composites of the combined irrigation effluent are analysed and the effluent in the final dam (dam 10) is analysed weekly. Soil samples from fourteen sites are analysed for their gypsum and fertilizer needs and the results are submitted to the Minister of Agriculture and Fisheries.

7.1 Coke Oven and By-product Area

Effluents from these areas constitute high flows and contain high concentrations of nitrogen, sulphate and phenols. Most of this effluent is used for coke quenching, but the overflow is passed to irrigation. The main sources of effluent from this area include:

(i) coke oven battery quench water, high in phenols and ammonia;

(ii) drainage effluent which collects in the gas seals on the gas lines due to condensation of the coke oven gas;

(iii) drainage of the water seal on the flare/burner;

(iv) drainage from the sulphuric acid loading area;

(v) drainage of seals from the hydrogen sulphide gas booster;

(vi) steam condensate from the sulphuric acid plant;

(vii) cooling water from the primary and secondary cooling systems;

(viii) intermittent drainage from the ammonia scrubbing towers which is high in dissolved ammonia and hydrogen sulphide gases;

(ix) overflow from the condensate sumps, which occurs when there is an operational problem. This effluent is high in ammonia and phenols;

(x) steam condensate from the ammonia boiler;

(xi) effluent from the oil separation drain;

(xii) drainage from the ammonia tank;

(xiii) steam condensate from the tar separator;

(xiv) surplus water in the tar tank area which is high in phenols.

7.2 Blast Furnace

This effluent originates in slag quenching and is high ammonia and fluoride.

7.3 Boilerhouse Area

This effluent originates from the tar separator and the tar washing area and is high in ammonia and phenols.

7.4 Seal Pots

The condensation in the seal pots on the coke oven and blast furnace gas lines produces and effluent high in ammonia and phenols.

7.5 Coke-oven Gas Holder

The condensate collected from the coke-oven gas is collected in a gas holder and overflows at a low flow, but is high in ammonia and phenols.

7.6 Steel Plant

The largest source of pollution in this area is the fluorspar and fluorsilicate used in steel manufacture. This effluent is high in fluoride. Various other streams originate in the steel plant and in the basic oxygen furnace.

7.7 Water Area

Effluents from this area include:

(i) overflow from the storage dams;

(ii) overflow form the filtration pump sump;

(iii) cooling tower blow-down;

(iv) leaks in the undergravel;

(v) closed system blow-down;

(vi) pumpstation area wash water (F, SS, TDS).

7.8 Blowers

This effluent is not badly polluted and originates when industrial water is used to cool the bearings on the blowers extracting dust.

7.9 Slag Heaps

Poor control over excessive spraying results in large volumes of effluents originating from the quenching of slag. This effluent is high in sodium and SS. The seepage from the basic oxygen furnace slag heaps was, prior to 1983, passed into the storm water system.

7.10 Continuous Casting Area

The cooling tower blow-down and sump overflow, primary and secondary dewatering tanks waste water, blow-down from the closed circuit water system and strong softener effluents are discharged into the irrigation system. This stream contains oil, SS, TDS, calcium and magnesium, sodium chloride and sodium and fluoride from flux powder.

7.11 Benzol and Sulphur Processing

This stream, consisting of seal water system overflow, coke oven-gas condensate, cooling tower blow-down and benzol tank wash water is small in volume but is contaminated by ammonia, phenol, benzol, naphthalene and dust.

Table 6 summarises the sources of pollution in the irrigation effluent.

TABLE 6 : Possible Sources of Pollution in the Irrigation Effluent

Source	Type of Pollution								
	F	Na	Phenol	CN	Low pH	N	Oil	SS	TDS
Coke oven		X	X			X	X	X	X
By-products		X	X	X	X	X	X	X	X
Blast furnace	X	X	X	X		X		X	X
Boilerhouse			X				X		
Seal pots			X			X			
Coke oven gas holder			X			X			
Burner			X			X			
Steel plant	X	X					X	X	X
Continuous casting	X	X					X	X	X
LBS			X			X		X	X

8 EVAPORATION EFFLUENT

The streams comprising this effluent are of such poor quality that they cannot be used for irrigation. The streams originate mainly at the demineralisation plant, although small volumes are drained from the boilers. Since these streams originate in very necessary processes, they cannot be eliminated.

The composition of the evaporation effluent does not need to comply with any quality standard since it is discharged into lined dams. Since the effluent is thus immobilised the Department of Water Affairs does not expect reports on the quality. However, the composition of the dams is monitored on a weekly basis.

The evaporation effluent by-passes the works effluent treatment facilities and is pumped to one of four solar evaporation dams. The evaporative capacity of the dams is 5,8 m^3/h. Due to the extension of the demineralisation plant the dams were not large enough to cope with the volume and a special permit has been applied for which will enable the overflow to drain into a natural pan, isolated from the river.

Since the commissioning of the evaporator in April 1986, which treats 1,4 Mℓ/day of regenerant waste from the demineralisation plant, the volume of flow to the dams has decreased.

Table 7 give the analysis of evaporation effluent for the period 1/7/1985 to 31/12/1985. Appendix 1 indicates that over the period July 1987 to June 1988 the average concentrations of the following components had increased from the 1985 figures: conductivity, 40% increase; SS, 800% increase.

TABLE 7 : Analysis of Evaporation Effluent for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Average	Standard deviation	% Variance
pH	6,9	3,5	51
Total hardness	790	419	53
Conductivity (µS/cm)	3 032	1 401	46
SS	36	63	175
Ca	688	403	59
Cl	191	185	97
F	1,8	1,8	100
Fe	0,39	1,4	101
K	15,1	10,1	67
Na	392	174	45
SO_4	1 367	604	44
SiO_2	13,3	5,3	40
PO_4	1,22	0,9	77

More than 50% of the samples collected during 1987 to 1988 did not fall within the operational limits with regard to pH, fats and oils, COD and OA.

9 STORM WATER

The control of pollution of storm water from the mills and steel plant is a priority, particularly as regards fluoride pollution from the steel plant. The storm water must comply with the General Standard. Application has been made for the slackening of the oil, phenol and SS standards from 2,65 mg/ℓ, 0,1 mg/ℓ and 25 mg/ℓ to 6 mg/ℓ, 0,2 mg/ℓ and 75 mg/ℓ respectively.

The storm water drain conveys storm water directly to the river without handling or treatment. The four main storm water lines are:

(i) coke oven area interceptor (Table 8), 50 to 90 m^3/h;

(ii) workshop area interceptor;

(iii) steel plant interceptor (Table 9), 15 m^3/h;

(iv) mill interceptor (Table 10), 10 m^3/h.

In term of quality, the steel plant storm water is often out of specification with regard to pH, fluorides, oil and SS. The storm water from the mills exceeds the standards in oil, fluoride and phenol, 45, 30 and 20% of the time respectively. Similarly the coke oven storm water exceeds the standards by 35, 93 and 50% most of the time. In addition, the average SS and fluoride concentrations are above the limit.

TABLE 8 : Analysis of Storm water from the Coke Oven Area Interceptor for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	% Variance	% Outside standard
pH	5,5 - 9,5	8,2	0,7	8	5
Conductivity (µS/cm)		843	261	31	
SS	25	20,6	31,8	154	20
Fats and oils	2,5	3,4	5,7	168	35
N	10	21,5	10,7	50	93
F	1,0	0,67	0,44	66	18
Phenol	0,1	0,17	0,29	171	50
CN	0,5	0,05	0,07	140	0

TABLE 9 : Analysis of Storm water from the Steel Plant Interceptor for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	% Variance	% Outside standard
pH	5,5 - 9,5	11,2	0,4	4	100
Conductivity (µS/cm)		2 439	1 091	45	
SS	25	87	70	80	84
Fats and oils	2,5	8,6	12,2	140	70
N	10	2,6	1,6	60	0
F	1,0	5,1	0,7	14	100
Phenol	0,1	0,03	0,03	100	5
CN	0,5	0,01	0,002	21	0

TABLE 10 : Analysis of Storm water from the Milling Area Interceptor for 1/7/1985 to 31/12/1985 (mg/ℓ)

Parameter	Standard	Average	Standard deviation	% Variance	% Outside standard
pH	5,5 - 9,5	7,9	0,3	4	0
Conductivity (μS/cm)		650	116	18	-
SS	25	7	4	59	0
Fats and oils	2,5	4,6	7,3	159	45
N	10	0,03	0,02	87	0
F	1,0	0,9	0,5	56	30
Phenol	0,1	0,06	0,7	117	20
CN	0,5	0,01	0,004	41	0

The storm water from the coke ovens is analysed every 2 hours for ammonia and a composite sample is analysed daily. Storm water from the steel plant, workshops and mills shows a large variance in flow and composition and samples are analysed weekly as three-day composite samples.

Storm water from the coke-oven, the blast furnace and the boiler-house areas are collected in dams 1 and 2 and only released to the river if the quality is sufficiently good. If the quality in dams 1 and 2 is not good enough the storm water is then pumped into dam 3 and used for irrigation. All other storm water lines are not monitored and flow directly to the river.

Table 11 gives the potential sources of pollution in the storm water.

TABLE 11 : Possible Sources of Pollution in the Storm water

Source	Type of Pollution								
	F	Na	Phenol	CN	Low pH	N	Oil	SS	TDS
Coal handling								X	
Ash process								X	
Raw material handling								X	
Coke oven			X			X			X
By-products			X		X	X	X	X	X
Blast furnace	X		X	X		X			X
Boilerhouse							X		
Ore storage								X	
Workshops							X		
Sulphuric acid plant									X
High pressure air plant								X	X
Mains water purification								X	
Steel plant	X	X	X				X	X	X
Casting	X	X	X				X	X	X
Mills							X		X

10 RUN-OFF

A seven year project is underway to control, isolate and enclose the slag, ash, tar and coke dumps. Any run-off at present is generally polluted and flows into the Ingagane and Buffalo Rivers.

11 RECOMMENDATIONS

11.1 Oils

One of the most problematic constituents in most effluent streams appears to be oils. Oil skimmers and oil removal systems are installed at various points in the effluent handling system but do not appear to be working effectively. Measures to overcome the problem could include:

(i) the effective removal of solids, which tend to be coated with oil, from all effluent streams as close to the source as possible;

(ii) the installation of oil skimmers at each sump;

(iii) the use of oleophilic disks or polypropylene skimming ropes in place of weirs;

(iv) investigating the height of the weirs in the oil sump at the effluent treatment plant.

Finally, analyses indicate that the oil level in the evaporation effluent, which consists mainly of waste regenerant chemicals fed from the ion-exchange columns to the evaporators, is unexpectedly high. The source of oil contamination in this stream should be identified and isolated.

11.2 Demineralisation Plant

The chemical usage and the overall water recovery of the system should be determined and compared to the theoretical figures.

Regeneration chemical requirements may be reduced by:

(i) installation of a carbon dioxide stripper prior to anion exchange to reduce the loading on the anion resin. This will lead to a savings in regenerant chemicals with longer cycle times prior to silica breakthrough;

(ii) installation of a second ion exchange system upstream from the first, in which the spent regeneration chemicals of the existing system are used. This upstream system need only be partly regenerated. Such a system has resulted in a 50% savings in regenerant chemicals at other factories;

(iii) investigate the imbalance in the acid and base regenerant chemical usage (60 kmol H^+/d and 33,8 kmol OH^-/d). The excess usage of acid necessitates lime addition prior to evaporation which increases the potential for scaling of the treat exchange surfaces.

(iv) adding lime to the strong cation regeneration effluent to precipitate calcium sulphate. The subsequent removal of this salt by filtration would significantly reduce the dissolved solids loading of the final effluent.

(v) "borrowing" ammonia and sulphuric acid from the by-product plant for use as regenerant chemicals. The evaporation of the spent regenerant chemicals would produce an ammonium sulphate stream (contaminated with the dissolved solids present in raw water and which are removed during ion-exchange) which could be "returned" to the by-product plant.

(vi) The installation of a buffer tank before evaporation to even out the variance in flow, concentration and composition of the ion-exchange regenerants. If sharp changes in composition occur in the evaporator feed, alternative crystal forms may be precipitated (and may be deposited on the heat exchange surfaces) and seed crystals may be dissolved.

(vii) investigating alternative methods of disposal of the softener regenerant waste streams.

It is possible that a treatment and direct reuse system as shown in Figure 1 could be applicable to the sodium chloride rich zeolite regenerant. The regenerant and rinse streams are purified and/or concentrated *in situ* using nanofiltration or reverse osmosis techniques and returned for reuse. Two low volume nanofiltration concentrate streams will be produced which can be further treated by evaporation.

Brine reclamation and reuse was studied (2) at a regeneration plant for ion exchange water softeners. The process was a modified lime-soda softening process which produced a sodium chloride brine of 95% purity at 160 g/ℓ. This brine was suitable for reuse as a regenerant brine after neutralisation with HCl. The lime-soda softening sludge, the volume of which was 11% of the waste brine, was the only waste.

11.3 Potentially Recoverable Chemicals

Most of the effluent streams contain process chemical which could possibly be extracted, purified and reused:

- Alusaf, Richards Bay, have installed a process for recovering sodium fluoride, which is used as a flux.
- sodium carbonate may be made from waste sodium hydroxide streams (both from ISCOR and from other Newcastle factories), carbon dioxide from waste gas streams and waste heat.

FIGURE 1

11.4 Recoverable Water

ISCOR have implemented various cascading systems, where waste water from one process is recycled for use in another process. However, a large volume of water is discharged in the form of recoverable water. Generally, water of acceptable quality for discharge to the river can, in many instances, be used in the factory.

11.5 Irrigation Water

The effects of the individual contaminants in the irrigation water on the soil structure should be determined. Steps can then be taken to segregate streams or to remove the detrimental contaminants at point source.

REFERENCES

(1) Vermeulen, C.J., Bronne van Water-en-groundbesoedeling, ISCOR, Newcastle, Report KWVR/9004/BD.PR, 19 November 1986.

(2) Burton, J. and Kreuch, E., Industrial Water Softener Waste Brine Reclamation, US EPA Project No. 12120 GLE, Report EPA-660/2/-2-74-007, February 1974.

SBM-STANDAARDE VIR AFLOPE

1 HERWINBARE AFLOOP - to River (Ingagane/Buffalo

pH

	Standaard	Doelwit	87-88 Jul-Jun	87 Jul-Des	88 Jan-Jun
S	5,5 - 9,5	95%	93,1%	93,7%	92,5%
B	5,0 -10,0	98%	96,0%	96,9%	95,0%
M	4,5 -10,5	100%	99,6%	99,2%	100 %
n			247	127	120
$\bar{x}$			7,81	7,87	7,75

Standard
Operational Std
Abs outside

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=I+750	80%	98,3%	97,4%	99,2%
B	<=I+1000	90%	99,6%	99,1%	100 %
M	<=I+1500	100%	100 %	100 %	100 %
n			234	116	118
$\bar{x}$			I + 266	I + 282	I + 250

Totale gesuspendeerde vaste stowwe

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=25	90%	94,7%	95,7%	93,4%
B	<=30	95%	96,1%	97,4%	94,5%
M	<=50	100%	99,0%	99,1%	98,9%
n			206	115	91
$\bar{x}$			10,5	11,3	9,6

Chemiese suurstof aanvraag

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=75	100%	99,4%	100 %	98,8%
B	<=100	100%	99,4%	100 %	98,8%
M	<=125	100%	100 %	100 %	100 %
n			154	69	85
$\bar{x}$			19,1	19,6	18,7

Fluoried as F

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=1,0	90%	96,4%	98,3%	94,5%
B	<=2,0	95%	99,1%	100 %	98,2%
M	<=4,0	100%	99,6%	100 %	99,1%
n			225	116	109
$\bar{x}$			0,30	0,16	0,44

Ammoniak as N

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=10	90%	99,6%	100 %	99,1%
B	<=20	95%	99,6%	100 %	99,1%
M	<=30	100%	100 %	100 %	100 %
n			232	116	116
$\bar{x}$			0,50	0,20	0,81

Natrium as Na

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=I + 90	90%	92,2%	95,4%	87,5%
B	<=I + 150	95%	96,1%	98,1%	93,1%
M	<=I + 180	100%	96,6%	98,1%	94,4%
n			179	107	72
$\bar{x}$			46,2	31,9	67,4

Suurstof geabsorbeer OA.

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=10	90%	94,1%	95,5%	92,3%
B	<=15	95%	97,5%	100 %	94,2%
M	<=20	100%	97,5%	100 %	94,2%
n			119	67	52
$\bar{x}$			4,9	4,2	5,8

Vette en olies

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=2,5(5,0)	50%	36,3%	28,4%	43,6%
B	<=6,0(7,0)	80%	72,6%	63,3%	81,2%
M	<=10,0(35)	100%	92,9%	92,7%	93,2%
n			226	109	117
$\bar{x}$			4,79	5,56	4,07

Fosfaat as PO4

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=1,0	90%	80,8%	81,8%	79,8%
B	<=2,0	95%	94,6%	94,5%	94,7%
M	<=4,0	100%	98,2%	99,1%	97,4%
n			224	110	114
$\bar{x}$			0,70	0,62	0,78

Fenol as C6H5OH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<0,1(0,18)	80%	68,6%	78,6%	59,0%
B	<0,3(0,34)	90%	89,1%	94,6%	83,8%
M	<0,5(2,40)	100%	95,6%	97,3%	94,0%
n			229	112	117
$\bar{x}$			0,13	0,10	0,16

Sianied as CN

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=0,5	95%	97,1%	99,0%	95,2%
B	<=0,7	98%	98,1%	100 %	96,2%
M	<=1,0	100%	99,0%	100 %	98,1%
n			208	104	104
$\bar{x}$			0,11	0,07	0,14

Coke Ovens — to River

2 KOOKSOONDE STORMWATERAFLOOP intercept & test for NH_4^+ if high then to irrigation

pH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	5,5-9,5	95%	97,4%	96,0%	97,8%
B	5,0-10,0	98%	97,4%	96,0%	97,8%
M	4,5-10,5	100%	98,3%	100 %	97,8%
n			115	25	90
$\bar{x}$			8,04	8,11	8,02

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=I+750	80%	90,3%	87,5%	91,0%
B	<=I+1000	90%	96,5%	100 %	95,5%
M	<=I+1500	100%	97,4%	100 %	96,6%
n			113	24	89
$\bar{x}$			I+561	I+754	I+509

Totale gesuspendeerde vaste stowwe

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 25	50%	90,0%	76,0%	94,1%
B	<= 30	80%	90,9%	80,0%	94,1%
M	<= 50	100%	94,5%	84,0%	97,6%
n			110	25	85
$\bar{x}$			16,3	29,2	12,5

Vette en olies

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=2,5(16)	90%	50,9%	37,5%	54,9%
B	<=6,0(30)	95%	70,8%	58,3%	74,4%
M	<=10 (182)	100%	85,8%	91,7%	84,1%
n			106	24	82
$\bar{x}$			6,7	6,0	6,9

Sianied as CN

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 0,5	95%	99,0%	100 %	97,8%
B	<= 0,7	98%	100 %	100 %	100 %
M	<= 1,0	100%	100 %	100 %	100 %
n			104	14	90
$\bar{x}$			0,06	0,06	0,06

Natrium as Na

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= I+90	90%	86,6%	91,7%	84,5%
B	<= I+150	95%	91,5%	95,8%	89,7%
M	<= I+180	100%	91,5%	95,8%	89,7%
n			82	24	58
x			I+80,9	I+82,1	I+80,4

Fenol as C6H5OH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<0,1(0,15)	80%	55,1%	73,9%	50,0%
B	<= 0,3	90%	90,7%	87,0%	91,7%
M	<= 0,5	100%	95,3%	91,3%	96,4%
n			107	23	84
$\bar{x}$			0,13	0,14	0,13

Fluoried as F

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 1	90%	90,2%	92,0%	89,7%
B	<= 2	95%	95,5%	92,0%	96,6%
M	<= 4	100%	100 %	100 %	100 %
n			112	25	87
$\bar{x}$			0,81	0,71	0,84

Chemiese suurstof aanvraag

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 75	95%	96,1%	100 %	95,1%
B	<= 100	98%	97,4%	100 %	96,7%
M	<= 125	100%	97,4%	100 %	96,7%
n			77	16	61
$\bar{x}$			22,3	13,9	24,5

Ammoniak as N

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 10	90%	100 %	100 %	100 %
B	<= 20	95%	100 %	100 %	100 %
M	<= 30	100%	100 %	100 %	100 %
n			113	25	88
$\bar{x}$			0,87	0,79	0,89

Basic Oxygen Furnace.

3 BSO STORMWATERAFLOOP

pH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	5,5-9,5 (12,4)	95%	4,08%	0,0%	6,4%
B	5,0-10,0 (12,4)	98%	4,08%	0,0%	6,4%
M	4,5-10,5 (12,6)	100%	4,08%	0,0%	6,4%
n			49	24	25
x̄			11,8	12,0	11,6

95% within 12,4

Na_2CO_3 spillage

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=I+750 (7000)	80%	10,4%	0,0%	20,8%
B	<=I+1000 (8800)	90%	12,5%	0,0%	25,0%
M	<=I+1500 (11400)	100%	14,6%	0,0%	29,2%
n			48	24	24
x̄			I+4802	I+7767	I+2837

Totale gesuspendeerde vaste stowwe

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=25(60)	50%	10,0%	4,2%	18,7%
B	<=30(160)	80%	10,0%	4,2%	18,7%
M	<=50(1740)	100%	45,0%	37,5%	56,3%
n			40	24	16
x̄			149	192	85

value to set to 50%

max figure

Vette en olies

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=2,5(16)	90%	30,8%	16,7%	53,3%
B	<=6,0(18)	95%	53,8%	45,8%	66,7%
M	<=10,0(49)	100%	76,9%	75,0%	80,0%
n			39	24	15
x̄			7,3	9,1	4,4

Fenol as C6H5OH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=0,1(0,2)	80%	63,9%	66,7%	60,0%
B	<=0,3(0,4)	90%	86,1%	85,7%	86,7%
M	<=0,5(2,1)	100%	91,7%	95,2%	86,7%
n			36	21	15
$\bar{x}$			0,17	0,12	0,25

Fluoried as F

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=1 (135)	90%	2,2%	4,5%	0,0%
B	<=2 (165)	95%	4,4%	9,1%	0,0%
M	<=4 (274)	100%	10,9%	22,7%	0,0%
n			46	22	24
$\bar{x}$			73,6	50,0	95,2

Chemiese suurstof aanvraag

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=75 (410)	95%	35,9%	47,6%	22,2%
B	<=100(424)	98%	64,1%	81,0%	44,4%
M	<=125(424)	100%	76,9%	90,5%	61,1%
n			39	21	18
$\bar{x}$			104,8	76,7	137,6

Ammoniak as N

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 10	90%	84,6%	100 %	62,5%
B	<= 20	95%	94,9%	100 %	87,5%
M	<= 30	100%	94,9%	100 %	87,5%
n			39	23	16
$\bar{x}$			7,2	2,2	14,2

Sianied as CN

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=0,5	95%	100 %	100 %	100 %
B	<=0,7	98%	100 %	100 %	100 %
M	<=1,0	100%	100 %	100 %	100 %
n			36	21	15
$\bar{x}$			0,01	0,01	0,01

Mill Storm water.

4 WALSERYE STORMWATER

pH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	5,5-9,5	95%	100 %	100 %	100 %
B	5,0-10,0	98%	100 %	100 %	100 %
M	4,5-10,5	100%	100 %	100 %	100 %
n			52	24	28
$\bar{x}$			7,7	7,6	7,8

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=I + 750	80%	100 %	100 %	100 %
B	<=I + 1000	90%	100 %	100 %	100 %
M	<=I + 1500	100%	100 %	100 %	100 %
n			52	24	28
$\bar{x}$			I + 439	I + 590	I + 310

Totale gesuspendeerde vaste stowwe

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 25	50%	100 %	100 %	100 %
B	<= 30	80%	100 %	100 %	100 %
M	<= 50	100%	100 %	100 %	100 %
n			39	21	18
$\bar{x}$			4,8	5,5	4,0

Vette en olies

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=2,5(8)	90%	64,9%	68,2%	60,0%
B	<=6,0(11)	95%	89,2%	90,9%	86,7%
M	<=10,0(31)	100%	94,6%	90,9%	100 %
n			37	22	15
$\bar{x}$			2,8	3,0	2,5

Fenol

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=0,1	80%	79,5%	66,7%	100 %
B	<=0,3	90%	100 %	100 %	100 %
M	<=0,5	100%	100 %	100 %	100 %
n			39	24	15
$\bar{x}$			0,05	0,06	0,03

Fluoried as F

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=1,0(7)	90%	14,6%	28,0%	0,0%
B	<=2,0(13)	95%	27,1%	41,7%	12,5%
M	<=4,0(56)	100%	50,0%	66,7%	33,3%
n			48	24	24
$\bar{x}$			5,5	2,9	8,1

Chemiese suurstof aanvraag

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<= 75	95%	97,9%	100 %	95,8%
B	<= 100	98%	100 %	100 %	100 %
M	<= 125	100%	100 %	100 %	100 %
n			47	23	24
$\bar{x}$			19,0	22,1	16,6

Ammoniak as N

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=10	90%	97,5%	95,7%	100 %
B	<=20	95%	97,5%	95,7%	100 %
M	<=30	100%	97,5%	95,7%	100 %
n			40	23	17
$\bar{x}$			1,65	2,81	0,08

Sianied as CN

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
S	<=0,5	95%	100 %	100 %	100 %
R	<=0,7	98%	100 %	100 %	100 %
M	<=1,0	100%	100 %	100 %	100 %
n			40	25	15
$\bar{x}$			0,01	0.01	0.01

evaporator feed.

5 VERDAMPER VOERWATER

pH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	6,5-8,5	95%	27,6%	29,0%	25,9%
M	5,5-9,0	100%	40,2%	44,1%	35,8%
n			174	93	81
x̄			6,7	7,3	6,0

hi / lo.

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<10 000	95%	92,1%	88,4%	96,4%
M	<15 000	100%	94,9%	91,6%	98,8%
M	<30 000	100%	98,3%	96,8%	100 %
n			178	95	83
x̄			4244	5653	2631

Totale gesuspendeerde vaste stowwe

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 25(545)	95%	62,5%	61,4%	64,6%
M	<=50(13216)	100%	79,4%	75,0%	87,5%
n			136	88	48
x̄			209	301	41

Vette en olies

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 1 (10)	98%	56,0%	54,7%	59,0%
M	<= 2 (10)	100%	56,0%	54,7%	59,0%
n			125	86	39
x̄			2,8	2,9	2,8

(?)

Feed - demin regen effluent.
Condensate to demin plant
Concentrate to brine dams

Oils are expressed as 2 as often rounded

Sink as Zn

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 5	98%	98,2%	97,5%	100 %
M	<= 10	100%	100 %	100 %	100 %
n			109	81	28
$\bar{x}$			0,4	0,4	0,3

COD

Chemiese suurstof aanvraag

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 1 (75)	95%	5,6%	8,2%	0,0%
M	<= 2 (165)	100%	5,6%	8,2%	0,0%
n			108	74	34
$\bar{x}$			20,8	23,6	14,7

?

Suurstof geabsorbeer

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 1 (20)	99%	44,4%	39,5%	55,3%
M	<= 2 (22)	100%	60,5%	55,8%	71,1%
n			124	86	38
$\bar{x}$			3,0	3,4	2,1

Fosfaat as P04

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 10	99%	100 %	100 %	100 %
M	<= 20	100%	100 %	100 %	100 %
n			131	92	39
$\bar{x}$			1,4	1,3	1,7

check analysis of drinking water; condensate
COD; Filter back wash.

Irrigation Water after Dam 10

5 BESPROEIINGSAFLOOP (DAM 10)

pH

after an alternate has been installed

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	7,6-8,2	95%	57,7%	52,0%	63,0%
M	7,4-8,6	100%	98,1%	100 %	96,3%
n			52	25	27
$\bar{x}$			8,2	8,2	8,2

Konduktiwiteit

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= I	95%	0,0%	0,0%	0,0%
M	<=I+250	100%	0,0%	0,0%	0,0%
n			50	25	25
$\bar{x}$			I+1917	I+2219	I+1615

Fluoried as F

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 1	98%	8,7%	9,1%	8,3%
M	<= 2	100%	10,9%	13,6%	8,3%
n			46	22	24
$\bar{x}$			29,1	21,5	36,1

Natrium as Na

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= I	95%	0,0%	0,0%	0,0%
M	<= I+30	100%	4,7%	0,0%	11,1%
n			43	25	18
$\bar{x}$			I+440	I+477	I+388

Suurstof geabsorbeer

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 1	90%	2,8%	0,0%	7,1%
M	<= 2	100%	8,3%	0,0%	21,4%
n			36	22	14
$\bar{x}$			20,4	22,4	17,3

Sianied as CN

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 0,5	98%	100 %	100 %	100 %
M	<= 0,7	100%	100 %	100 %	100 %
n			37	22	15
$\bar{x}$			0,033	0,015	0,060

Ammoniak as N

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 2	99%	30,2%	30,4%	30,0%
M	<= 5	100%	69,8%	56,5%	85,0%
n			43	23	20
$\bar{x}$			5,1	4,9	5,3

Fenol as C6H5OH

	Standaard	Doelwit	Jul-Jun	Jul-Des	Jan-Jun
B	<= 0,1	95%	5,0%	8,7%	0,0%
M	<= 0,3	100%	35,0%	47,8%	17,6%
n			40	23	17
$\bar{x}$			0,522	0,464	0,600