An operational review of the belt-filtration plant at Chemwes Limited

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SYNOPSIS

The belt-filtration plant at Chemwes Limited has been in operation for three years. The plant design is discussed. Operational and engineering problem areas are reported, and where possible the modifications or practices that led to their solution are mentioned.

Capital and operating costs, together with selected general operating data, are also included.

SAMEVATTING

Die bandfiltreeraanleg van Chemwes is al vir 'n tydperk van drie jaar in werking. Die aanlegontwerp word bespreek.

Probleme ondervind in die bedryf- en ingenieursgebiede word behandel en waar moontlik word die veranderinge bespreek wat gelei het tot die oplossing van die probleme.

Gegewens oor kapitaal- en bedryfskoste, sowel as uittreksels van bedryfsdata, is ook ingesluit.

Introduction

In late 1976 an optimization study was completed for the Stilfontein Uranium Project (later to become Chemwes Limited), which recommended belt filters in preference to countercurrent-decantation thickeners or drum filters for the treatment of Stilfontein slimes-dam material. As a result, belt filters were included in the 'frozen' process design.

Four established suppliers of belt filters tendered in 1978 and, after adjudication, the order was placed with Elgin Engineering for a Filters Gaudfrin design plant to be manufactured in South Africa. The Chemwes plant, to treat 270 000 t per month of reclaimed gold-plant residue slimes for the recovery of uranium, was commissioned in June 1979[1] (Fig. 1).

Design Parameters

Doubts about the mechanical reliability of belt filters were still being expressed during the design stage, and a conservative approach was adopted. Only 85 per cent availability was assumed for the belt-filtration plant, which, for the predicted duty of 12,5 t per square metre per day, required approximately 850 m^2 of filter area.

A soluble loss of 2 per cent was planned at a wash ratio of 0,6:1 (i.e. 0,6 m^3 of wash per ton of solids), giving approximately 1,4 m^3 of pregnant solution per ton of solids. The consumption of a guar-based flocculant was estimated at 100 g per ton treated.

Description of the Plant

Nine filters were installed, each with an area under vacuum of 94 m^2. Each filter operates as a separate unit with its own vacuum pump, filtrate system, and filter-cake repulper, and has its own local control panel showing the drive system and process alarms associated with that filter, together with vacuum reading, belt-speed indicator, and speed-adjustment buttons.

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The filter support structure is a 316L stainless-steel folded-section design with only three major points of support. This uncluttered structure allows easy access under the filter, and is neat and simple in appearance. The holding-down bolts and nuts are mild steel with a corrosion-protective covering.

Each filter has two rubber drainage belts, each belt with a central vacuum box and the two belts with a common head and a tail pulley (1,4 m in diameter). Each belt is approximately 60 m long and 2,13 m wide, and is constructed of five-ply polyester fabric with rubber covers of 20 mm at the top and 6 mm at the bottom. The drainage grooves are tapered to a single row of 15 mm holes drilled at the low point of each groove in the centre of the belt, the holes being situated over the vacuum box. The two belts per filter each have rubber-sided shoulders of triangular cross-section to produce the necessary shallow trough on top of the belt to contain the slurry and wash water. Each belt has a rubber wear-strip fixed to its underside, which slides on top of the vacuum box.

The belts are separated from each other by tracking–guide rollers, and are supported on beds of water in corrugations of the belt-support decking, which is made of 304L stainless steel. The belt effectively slides over the wet surfaces of the stainless-steel decking (Fig. 2).

Distinctive features of the pulleys are the two shallow channels required to accommodate the raised-vacuum wear-belt sections on the underside of the belts. The head and tail pulleys are of rubber-lined mild steel.

The head-pulley drive system is via a hydraulic motor through a planetary gearbox. A 75 kW electric motor drives the hydraulic power pack, delivering pressures of up to 15 MPa. Operating pressures are in the range 6 to 11 MPa depending on the materials used on the contact surfaces between the vacuum box and the belt, the condition of the surfaces, and the effectiveness of the lubricating water supply.

Belt speeds can be adjusted between 5 and 25 m/min, but the operating speed is typically about 15 m/min.

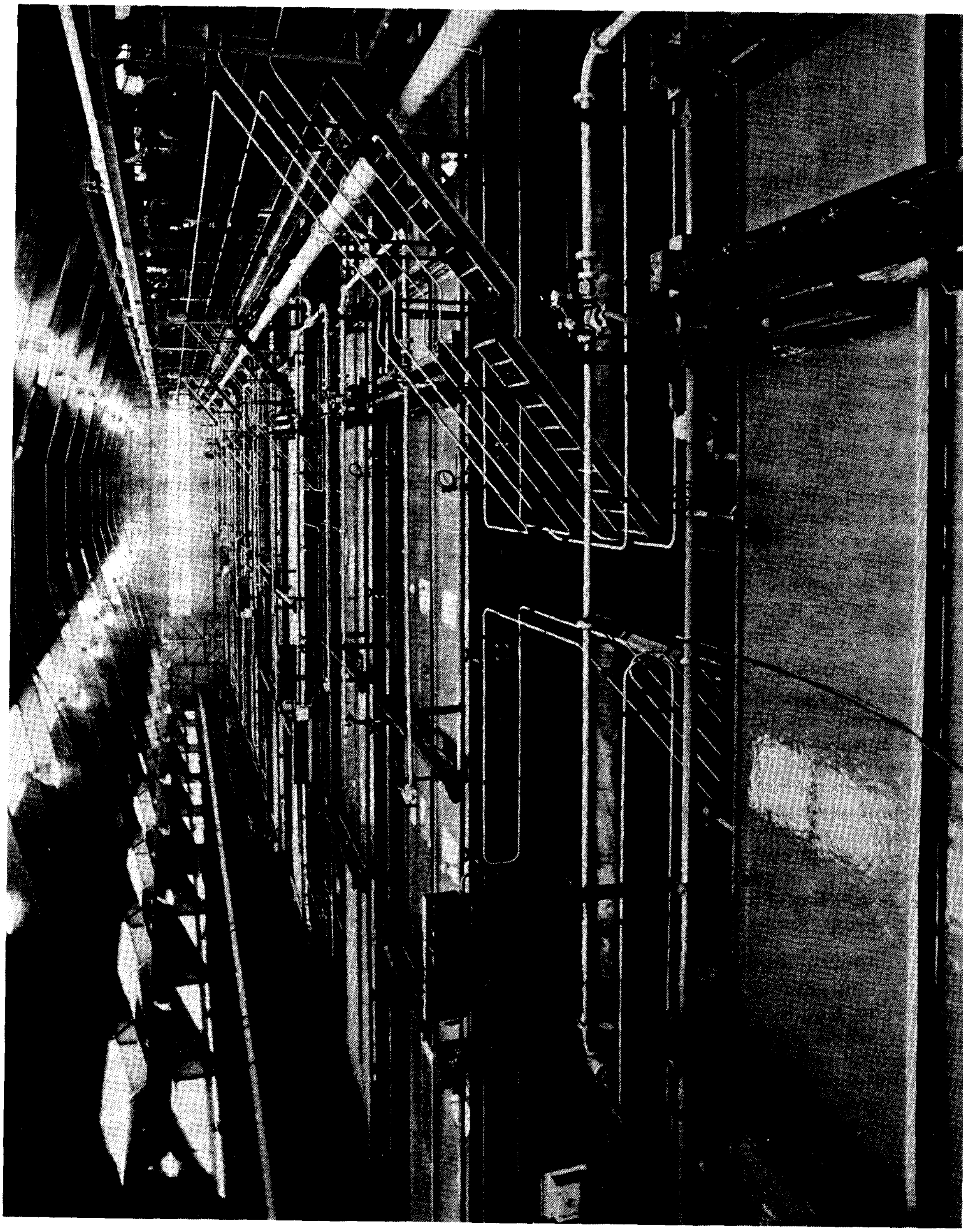

Fig. 1—The Chemwes belt-filtration plant

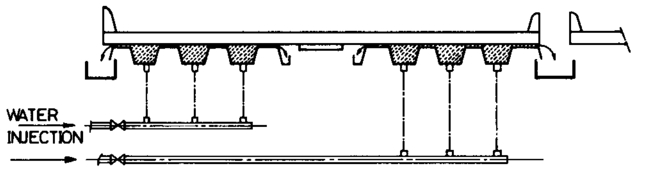

Fig. 2—The system of belt support

A filter cloth rests on top of each filter belt. On cake discharge, the cloth separates from the belt and returns via a separate set of return rolls, tensioning rolls, and tracking rollers back to the feed end of the filter. Tracking is achieved via a pivoted pneumatically actuated guide roller. Cloth-edge sensing is by limit switches with wire feelers situated on each side of the cloth, which actuate the movement of the guide roll. The guide roll oscillates between two fixed positions, which thereby forces the cloth to move from side to side between the limits set by the feeler switches (Fig. 3). Dewrinkling of the filter cloths is achieved by a bowed roller immediately prior to the cloth returning to the top of the filter.

Cake discharge and cloth cleaning are achieved by high-pressure water sprays through fine nozzles set at 150 mm intervals on pipes in front and behind the cloth. Spray water joins the discharge slime in the repulper to provide the necessary dilution.

Vacuum is generated for each filter by a single rotary vacuum pump with a capacity of 7000 m^3/h. (One stand-by vacuum pump for the other nine was also installed.)

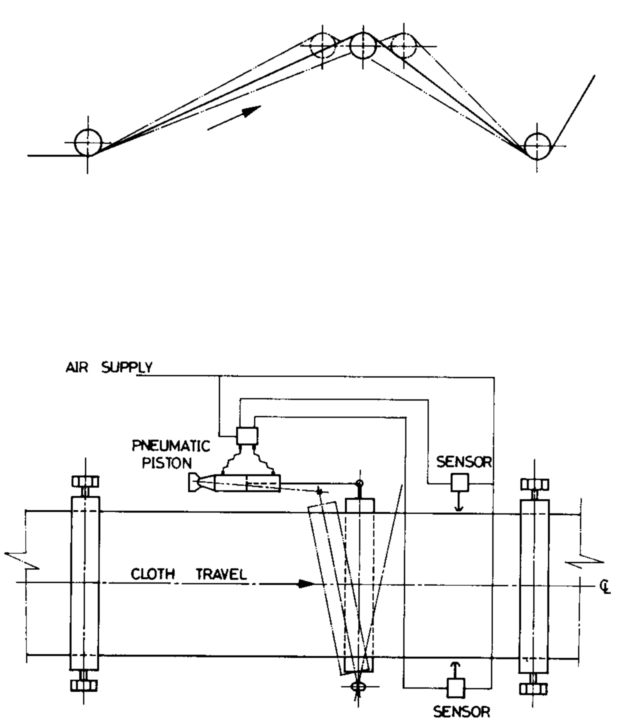

Fig. 3—The cloth-tracking system

The vacuum pump is connected through a mist arrester (to which spray water can be applied to scrub out acid mist prior to the pump) to the clean and dirty filtrate receivers, and from there to the filter via the vacuum lines. The vessels and pipes are all rubber-lined. A vacuum of approximately 55 kPa is typical.

Each filter has two vacuum boxes, one for each belt. Vacuum is applied through the stainless-steel vacuum box, through the holes in the centre of the drainage belt to the filter cloth. Each vacuum box has wear strips fitted to the top that slide against the rubber wear strip on the underside of the belt. Water is injected for lubrication and sealing through inlet points in the strips (Fig. 4). Most of this water joins the filtrate.

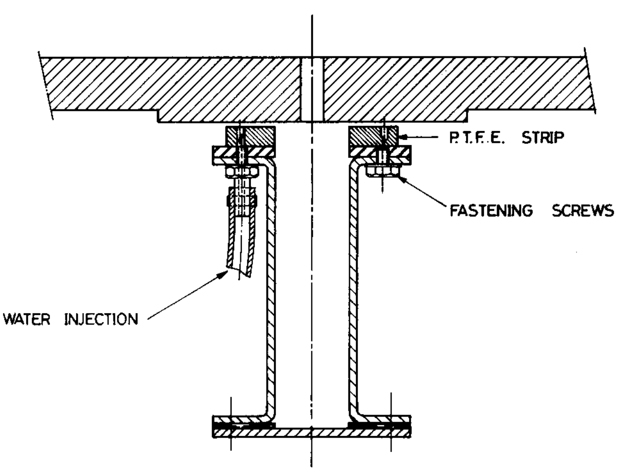

Fig. 4—A vacuum box

Slurry feed to the filters is pumped from the leaching section through a pipeline of gradually reducing diameter (250 mm to 150 mm, terminating after the last filter) calculated to allow for the reducing flow after each filter offtake. The filter-feed pump (d.c. drive, variable speed) has a recycle line back to the filter-feed pachuca. A conductivity sensor controls the variable-speed pump to maintain a steady head in the recycle column, effectively giving a steady feed pressure to the filters.

Slurry offtake from the main filter-feed line to each filter is via a pneumatically controlled valve activated by an ultrasonic level detector on one belt. The slurry offtake discharges into a flocculator, which is simply a tank with slow-moving agitator. Flocculant is added through a manually adjusted rotameter, and the residence time in the flocculator can be varied from approximately 10 to 30 seconds by the addition or removal of weir bars on the overflow (a typical time is approximately 15 seconds). Dirty filtrate, which originates from a partitioned first section of the vacuum box in the cake-formation zone, can also be recycled into this tank.

A manually adjustable distributor is positioned between the flocculator and the fish tails that feed slurry into the cake-formation zone. The distributor adjusts the feed between the two belts to compensate for the fact that the slurry level is monitored on only one belt. Infrequent adjustment is required.

The filter is divided into four main zones by dams consisting of moveable rubber flaps across the width of each belt. These dams divide the filter into the following four zones:

(i) feed or cake-formation zone
(ii) a short cake-dewatering zone, which prevents the carry-over of pregnant solution into
(iii) the cake-wash zone, and
(iv) a final dewatering or drying zone prior to discharge.

A single-stage cake wash is employed, using barren solution returned from the continuous ion-exchange section (NIMCIX). The level in the cake-wash zone is controlled by a simple on-off diaphragm valve on the line between the barren solution and the cake-wash zone, which is activated by conductivity probes.

Another feature of the design is the incorporation of sophisticated systems of cloth washing and caustic treatment. The cloth-washing system consists of a high-pressure water pump (3,5 MPa) with an oscillating spray pipe fitted with nozzles for each filter. Control panels monitor the washing operation. The caustic-washing system has a caustic tank and pump for distribution to the top of each filter and allows the cloth to be washed by the drawing of caustic solution by vacuum through the cloth.

Problem Areas

Belts

Rubber drainage belts to be manufactured in South Africa were specified in the original order. However, it soon became clear that the local manufacturer of conveyor belts lacked sufficient experience in the fabrication of large drainage belts.

The main construction fault was that the belts were not straight, which led to tracking problems, and good belt tracking is critical in keeping the drainage holes in the belt centrally positioned over the vacuum box. An additional problem of the poor belt tracking was that the dams separating the various sections on top of the filter (i.e. separating the cake-formation zone from the first drying zone), being fixed, tended to leak first at one side and then at the other as the belt moved from side to side. The belt-tracking problem was, to a great extent, overcome by the fitting of a sturdily constructed set of belt-tracking rolls on the bottom belt-return section of the filter immediately prior to the tail pulley but after the belt-tracking pulley.

The original lack of straightness is believed to be due to internal stresses. These stresses seem to have been partly relieved since the belts are now generally straighter.

The particularly crooked belts on one filter were replaced with imported items. These are very straight, and no problems have been experienced with these belts to date.

More seriously, cracks appeared in the splices, leading to separation of the splice plies. This seems also to have been mainly a fabrication problem. The belt plies were widely spread through the thickness of the belt, which resulted, when the belt passed the head and tail pulleys, in the outside plies of the belt being tensioned and the inside plies being compressed. From visual inspections it appears that the ply material failed, and the crack then progressed to the belt surfaces. The cracks occurred on both the upper and the lower surfaces. Regular repairs were made by the vendors, but eventually the splices deteriorated to such an extent that it was necessary to remove them and insert new sections. These inserts, of course, doubled the number of splices on one belt. So far eleven inserts have been made, with five still to be completed. However, this procedure has been shown to offer only a temporary reprieve: the new splices, which were carried out with great care with much longer steps, are now starting to fail. Continued attention may extend their life for a few more years.

Problems were also experienced with the cracking of belt shoulders. It is surmised that the material used was too hard, and that the tension effects as the shoulders passed round head and tail pulleys caused the material to crack.

The belts are supported on the top travel by a water bed and stainless-steel belt-support trays. Water sprays were fitted on the belt return to wash any slime from the belt before it passes round the tail pulley and on to the belt-support trays. This washing was not always carried out efficiently, with the result that, where the underside of the belt came into contact with the belt-support trays, the trays were worn away. The costs of material replacement are not high, but the location makes replacement particularly difficult.

Belt-return Rollers

An unexpected but persistent problem was the failure of the belt-return rollers. Numerous designs were tried, but a consistent mode of failure, namely at welds, has not yet been overcome. These rollers operate in a wet, mildly acid environment, but they are rubber-covered. Where rubber failures have occurred, the failures can be explained by stress-crack corrosion. However, most weld failures have occurred under the rubber coating. It is believed that the failures have been due to fatigue at the welds. Designs that eliminate stressed welding altogether will be tested. In addition to the downtime resulting from these failures, damage was caused to cloths by broken rollers falling onto the returning cloth.

Drive Pulleys

A number of drive pulleys have required relagging with rubber. These filters experienced belt slip at times, which was often associated with high torque due to vacuum-box problems or experiments. It is very awkward to work on these pulleys *in situ*. However, when splice problems occurred and belts had to be cut, the opportunity was taken to reline the drive pulleys that showed high rates of wear. The relining of pulleys without cutting of belts would be a very difficult exercise.

Vacuum Boxes and Wear Strips

This area has been the subject of much attention, experimentation, and development, which are still continuing. The filters were commissioned with the standard rubber wear strips attached to the underside of the belts sliding against P.T.F.E. wear strips bonded to stainless-steel backing plates. The backing plates were bolted to the top of the vacuum boxes. The filters were commissioned at low vacuum (approximately 40 kPa) to give a low torque for a period of approximately 12 days to allow the filters to bed in; theoretically, a layer of P.T.F.E. is worn off the wear strips and coated onto the rubber wear belt. This never really occurred to the extent that the predicted lower torques were achieved. The

(2) three Chemwes fitters were more or less permanently working on the filters or their supporting equipment on day shift, and
(3) the vendors provided between 1 and 3 (averaging approximately 2) more fitters free of charge 5 days per week for approximately one year.

The vendor fitters concentrated mainly on overcoming the problem of wear-strip life and making modifications.

Experiments with vacuum-seal water consumption indicated that improved wear-strip life would be achieved if the number of addition points and the water flowrate were increased. The water flowrate was increased from 5 to 10 m^3/h, and the number of addition points was increased twelvefold—from one every 3 m to one every 250 mm. From this point onwards, the guaranteed wear-strip lives began to be achieved.

The following wear-strip materials were tried out at the same time, but none showed any real promise: black polyethylene, black polyethylene with P.T.F.E. inserts, and glass-impregnated P.T.F.E. The general effect was to reverse the previous wear pattern: minimal wear was now experienced on the wear strips, but increased wear occurred on the rubber wear belt (often with grooving). Higher torques were also experienced, and these resulted in the slippage of drive pulleys and more rapid wear on the pulley lagging.

Recently, a more successful combination of materials was tested. These tests involved changing of both the wear-strip material attached to the belt and the wear strips on top of the vacuum box. The new wear-belt material still had a rubber base but with layers of polyester fabric in the rubber matrix (marketed as *flat transmission belting*). The vacuum-box wear-strip material was changed to high-density polyethylene (H.D.P.E.), and the number of water addition points was reduced to the original number of 1 every 3 m. Several designs of H.D.P.E. wear strip are on test. All look promising at this stage with regard to wear and torque. Lives for H.D.P.E. wear strip (20 mm) and polyester rubber wear belt of about 30 000 hours are predicted, and the torque has been reduced by approximately 40 per cent for the same equivalent vacuum. H.D.P.E. has a lower

the cake-wash zone, running behind the cloth into the belt grooves to join the filtrate. Folding in of the cloths at the edges also led to wear and, finally, failure at the crease. Also, if the cloth edge remained folded on the cloth return, the edges could not be sensed accurately, leading to severe tracking problems. Problems were also experienced with fraying of the cloth edges.

A great improvement in cloth performance was achieved with cloths of needle felt (also a polyester material). These cloths are of a totally different physical construction, and have a thicker, stiffer nature that permits more-positive sensing and tracking with less risk of edge folding. These cloths are still in use today, the average cloth life being about 74 days. This includes cloths that are replaced before being worn out because of physical damage. One disadvantage of needle-felt cloths is that they have a tendency to stretch. This has been overcome by the allowance of a minimum amount of slack when new cloth is fitted. The stretch is then taken up either by the normal cloth-tensioning device or by the fitting of extensions on the cloth-return rollers to lengthen the cloth-return path. Another disadvantage of needle felt is that it tends to give lower vacuums than woven cloths. This may be due to the effectively tighter *weave* of woven cloths, but differences in filter duty have not been observed.

A definite advantage of needle-felt cloths is that joints can be made by hot-air welding (melting) of overlapped sections of cloth. On average, a filter recloth, including the time for the removal of the old cloth, can be completed in about 3 hours. Holes in the cloth can be repaired by the same technique, and repair times average about half-an-hour, the time taken obviously varying with the complexity and size of the patching.

Experiments were also carried out with a needle-felt cloth produced by a rival manufacturer in which the necessary width was achieved by the joining of two sections of cloth along the centre. These cloths also tended to stretch in use, but, possibly owing to uneven tensions resulting from the joins, the rate of stretch was not the same in both halves of the cloth. One half of the cloth was still in tension while the other side of the cloth had a loose, wavy edge that tended to fold in, causing the whole cloth to become untrackable.

The cloth-tracking arrangement is still maintenance-intensive. As described earlier, the cloth is constantly tracked from side to side between the limits set by limit switches. On some filters this can result in the activation several times a minute of the switches and cloth-tracking roller, which is moved pneumatically. This area is also subject to dripping acidic solutions, which adds to the problem of maintenance. Improvements must still be made in this area.

Cloth rollers at the cake discharge were initially covered with rubber, but rapid failure led to their replacement with stainless-steel rollers. These rollers have performed well in this application, but the bearings tended to fail prematurely because of the acid spray from the cloth-cleaning sprays.

Initially, barren solution (as for the cake wash) was utilized for the cloth-cleaning sprays, but the resultant acid mist in the building made conditions very uncomfortable for staff and was extremely corrosive to the steelwork. Industrial water is now used. Fine-mesh filters in the cloth-spray lines have greatly reduced the problems of blockages of the cloth-spray nozzles by wood chips and other trash.

The sophisticated high-pressure cloth-washing system with oscillating spray pipes and the caustic cloth-washing system proved unnecessary, and most of the systems have been removed.

Vacuum Pumps and Filtrate Systems

Initially, the vacuum box was adjusted with a clearance of about 2 mm from the rubber belt, and vacuum had to be applied quickly to pull the belt down onto the vacuum box. Significant downtime was experienced because the large clearances set to improve the life of the wear strips resulted in problems in the application of vacuum. This was overcome by the installation of a rapid-opening butterfly valve on the main vacuum line.

The filtrate pumps have been high maintenance items, the model used being mounted on the side of the filtrate receiver. Breaking of shafts has been a problem, as has high impeller wear. Some cost saving has been achieved by the reconditioning of impellers.

Industrial water is used for the sealing of the vacuum pump, but serious scaling occurred in the pumps, which led to jamming of the impellers. This has been overcome by the addition of a chemical additive to the water. The situation is not completely satisfactory as the seal water operates on a single-pass system, and hence the value of the chemical additive is immediately lost.

Some impeller pitting has also been experienced. Ceramic coating of the impellers, shafts, and shell is to be tried to reduce the sealing and pitting problems.

A regular problem with the vacuum pumps has been the impeller coming loose on the shafts. Reconditioning is time-consuming and expensive. Impellers on shafts are now shrink-fitted, although the initial vendor information indicated that a slip fit was adequate.

Repulpers and Discharge Pumps

The repulpers have generally performed well. However, a design fault was the positioning of the motors and gearboxes too close to the agitated slurry, where they were subject to splash and were not in an easy position for maintenance.

A vertical froth pump was installed to handle the discharge from the repulper. It is now felt that this was not a good choice and a horizontal spindle pump would be more suitable. The bearings are a weak feature, and too frequent failures are encountered with the impellers.

Filter Drives

The filter drives are hydraulic. The hydraulic pumps have performed extremely well after overcoming some initial hydraulic filter problems, and minimal problems have been experienced with the hydraulic motors.

However, the planetary gearboxes have given serious problems. The design seems to be inadequate. The initial problems were due to the falling out of bearings. Although this was solved by a modification to the locking plate, the life of the bearing continued to be short (approximately 1500 hours as against a design of 50 000 hours), and rapid tooth wear was experienced. Modifications were carried out by the suppliers, but frequent attention is still required. The condition of the gearbox is monitored closely by the examination of oil samples and by the use of magnetic plugs at the drain points. The life of the bearings has been extended to about 4500 hours and the tooth wear reduced. However, cracks have been found in certain gears.

Soluble Loss

The loss of dissolved uranium has been an intermittent problem. For long periods, acceptable losses (close to the 2 per cent design figure) were achieved. However, at other times losses as high as 6 per cent for a month or more were experienced. These high losses seem to be associated with periods when very fine slime (as fine as 45 per cent smaller than 10 μm) is being filtered. The correlation, however, was not consistent.

Sampling problems were also experienced in that it was not possible for the high soluble losses found in repulper samples to be correlated with the soluble losses in the filter-cake discharge. Frequently, negligible soluble losses were found in the filter-cake discharge when significant values were found in the repulper, and these differences could not be correlated with any known solutions entering the repulper. It was thought that residual filtrate in the filter-belt grooves and filter cloth could be falling into the repulper at the head pulley after the cake discharge. Trays were constructed to collect these drippings, and their values were found at times to be high (similar to those of the pregnant solution), but high unexplained discrepancies still remained between the soluble losses in the repulper and those in the cake, even after most of these drippings had been removed. A satisfactory explanation of the problem is still being sought. Fig. 5 gives the results for the years 1980 and 1981, indicating the monthly average soluble loss, to-

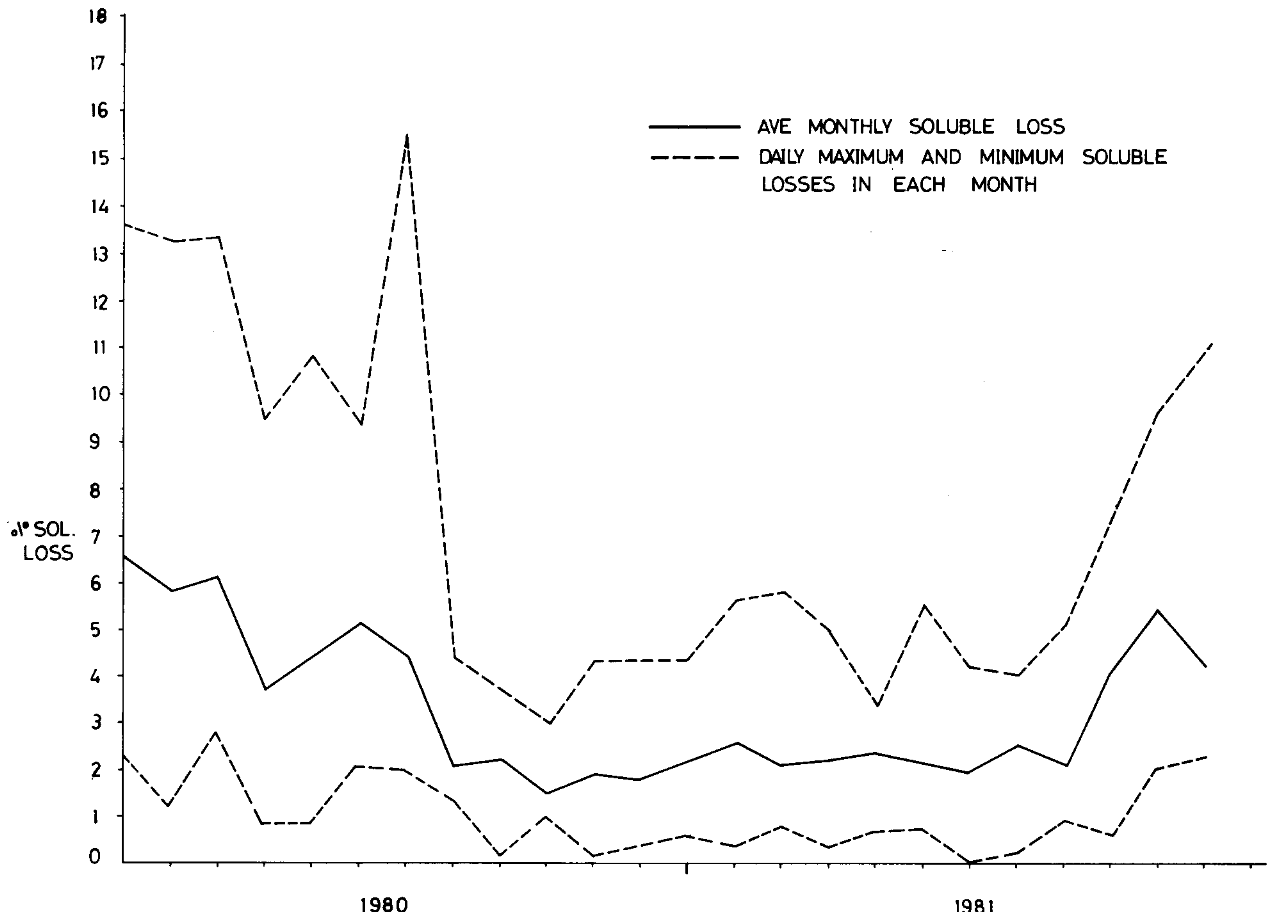

Fig. 5—Soluble losses in 1980 and 1981

gether with the daily maximum and minimum in that month.

Corrosion

The filters were constructed of stainless steel, which proved to be a wise choice as no deterioration is apparent. The mistaken use of mild-steel holding-down bolts for the installation of the stainless-steel frames has so far proved not to be detrimental. Careful attention is paid to the exclusion of moisture from the bolt and nut coverings, but this area may prove to be a long-term weakness. The rest of the building and walkway supports are made of mild steel with a coating of bituminous paint. The early use of acid solutions as cloth washes caused a permanent acid mist in the building, with the result that corrosion, particularly of the building steelwork, is taking place. This will require regular maintenance in the future. Mild-steel components on the upper structure of the filters have also shown some corrosion, but relatively easy access has enabled good control to be exercised. Generally, it would have been advisable to include as much stainless steel as possible in the original design since corrosion-preventative maintenance is costly.

All the concrete floors within the building were covered with a polyester screed. The continual acidic drippings have caused the coating to deteriorate in certain areas (mechanical damage may also have contributed to the deterioration), but generally the concrete is still in good condition.

Control of Filter Feed

Careful attention was paid to the design of the filter feed. Problems of level control in the feed-zone level were experienced initially because the system of level control was unreliable. However, these problems have been overcome since the control system was linked to a Honeywell T D C 2000 system.

The design of the filter-feed system was intended to obviate too high a pressure drop across the automatic feed valves. This has not been totally successful, and the feed valves have not worn satisfactorily. The original rubber-lined diaphragm valves gave average lives of about 2 months and failed by wear either through the diaphragm or the valve body. Butterfly valves were tried but were not successful.

A pinch (sometimes called a squeeze) valve is being tried at present, and the wear results look very promising. Good control is also being achieved.

Tonnage Control

Measurement of mass flow on the feed line to the filters was installed to give the operators a direct indication of performance shift by shift. Change in the addition rate of flocculant is the main parameter used by the operator to adjust the tonnage throughput. Other methods are available, but flocculant addition is the most convenient. This may at times be a contributory cause of the high soluble losses. The consumption of flocculant can vary from 50 to 110 g/t of the guar-based flocculant used.

The filter availability is generally fairly consistent (about 92 per cent on average), but the duties can vary considerably from day to day (from 9 to 14 t/m^2 per day).

Instrumentation

None of the staff of Chemwes or the management contractor had any real experience in operating belt filters. This gave rise, as mentioned earlier, to a conservative design philosophy, together with a pessimistic view of the things likely to go wrong, resulting in over-instrumentation on the filters and over-annunciation of alarms. The local control panels for each filter are currently largely ignored by the operators since they display flashing lights for items long since redundant or of no interest to the operator. A review of these panels is under way so that they can serve as a useful monitor of the filtration operation.

Capital Cost

Table I provides some idea of the capital costs of the total filtration plant. The total sum does not include the management contract fee, nor the commissions normally associated with capital projects. The total cost compared very favourably with the budgeted costs.

The headings of the individual items may not appear completely logical, but certain cost groupings are dictated by the division of the total job among the sub-contractors.

TABLE I

BREAKDOWN OF CAPITAL COSTS (1979 MONEY) FOR THE BELT-FILTRATION PLANT

		R × 10^3
1.	Filters, drives, repulpers, platforms, etc.	4 734
2.	Civils	1 016
3.	Piping, fabrication, and erection	581
4.	Building and painting	529
5.	Vacuum pumps	302
6.	Instrumentation	147
7.	Filtrate system, receivers, and pumps	165
8.	Cables, cable racking, erection, etc.	133
9.	Flocculant make-up, feed pump, and flocculators	100
10.	Spillage handling	60
11.	Cake-wash tank and pumps	55
12.	Cloth wash	36
		7 858

Operating Costs

Table II shows estimated operating costs for the two-year period 1980–1981. It should be noted that serious inflation was experienced over this period. Certain plans are in hand to reduce working costs (i.e. the use of H.D.P.E. wear strips), but it is expected that inflation, together with the need for the replacement of rubber belts, will offset any savings.

Certain of the costs are estimated, but they are believed to be fairly accurate.

TABLE II

BREAKDOWN OF OPERATING COSTS FOR THE TWO YEAR PERIOD 1980–1981 FOR THE BELT-FILTRATION PLANT

			R	Cent per ton treated*	
Stores	Flocculant	732 000		10,6	
	Other	1 302 000†		18,9	
			2 034 000		29,5
Power‡			656 000		9,5
Water‡			280 000		4,1
White wages§			392 000		5,7
Black wages§			189 000		2,7
Renewals and replacements**			551 000		8,0
			4 102 000		59,5

* 6 895 000 tons treated

† Includes filter cloths and general maintenance of all filter-plant equipment

‡ Estimated

§ Operating and maintenance labour

** Include vacuum wear strips, drainage belts, replacement of all vacuum pump motors (initial installation undersized) vacuum-box modifications, and rectification of automatic lubrication system

Causes of Filter Downtime

The information in Table III was extracted from data that were accumulated during the two-year period 1980–1981 inclusive.

It should be noted that many items moved, with the accumulation of down-time data, from particular failures or reasons, into the *General Maintenance* category because planned maintenance prevented the failures that had been occurring in the earlier part of the review period.

TABLE III

CAUSES OF FILTER DOWNTIME FOR THE YEARS 1980–1981

		% of total downtime
1.	Rubber-belt repairs and tracking	15,3
2.	Operating problems external to filter plant*	13,2
3.	Patching and replacing cloths	12,6
4.	No feed to filter including feed-line chokes	10,8
5.	General maintenance	8,2
6.	Power cuts and failures	7,6
7.	Vacuum strips and boxes	7,2
8.	Slime feed valves	4,2
9.	Cloth-correcting rollers and sensors	3,1
10.	Repulper-pump repairs	2,9
11.	Vacuum-pump repairs	2,5
12.	Power-pack repairs	2,4
13.	Belt-return rollers	2,4
14.	Cloth sprays and strainer cleaning	2,2
15.	Control-panel problems	1,3
16.	Gearbox repairs	1,1
17.	Cloth-roller defects	0,9
18.	Filtrate pumps and receivers	0,9
19.	Other filter problems	1,2
		100,0

* Includes problems on continuous ion exchange (e.g. pregnant-solution tank full), residue disposal, water and compressed-air shortages, and maintenance stoppages on other sections

General Operating Data

The information in Table IV was extracted mainly for the two-year period 1980–1981 and summarizes the

TABLE IV

SELECTED OPERATING DATA

1.	Ratio of pregnant solution to solids	1,47 : 1
2.	Wash ratio (wash : solids)	0,5 : 1
3.	Daily duty	12,3 t/m²
4.	Soluble loss	3,4%
5.	Slime grading smaller than 200 mesh	73,9%
6.	Filtrate suspended solids	304 p.p.m.
7.	Flocculant consumption (guar)	69 g/t
8.	Average cloth life	74,1 days
9.	Filter availability	92,4%
10.	Filter running time	90,8%
11.	Relative density of filter feed	1,495
12.	Temperature of filter feed	46°C
13.	Average vacuum per filter (approximate)	55 kPa
14.	Vacuum capacity per filter	7000 m³/h
15.	Vacuum per m² of filter area	74,5 m³/h
16.	Life of P.T.F.E. wear strip* (approximate)	3000 hours†
17.	Life of rubber wear belt* (approximate)	3 years
18.	Consumption of vacuum-box lubrication water (approximate)	7 m³/h‡
19.	Filter speed (approximate)	15 m/min
20.	Time to patch holes in filter cloth (approx.)	½ hour
21.	Time for filter recloth (approximate)	±3 hours

* The H.D.P.E.–polyester wear-belt combination is predicted to extend these lives to about 30 000 hours each

† 8 000 hours have been achieved

‡ 0,16 m³ per metre of vacuum box

operating data, some of which were mentioned earlier in this paper.

Conclusion

For the Chemwes liquid–solid separation stage, belt filters have proved to be viable machines. They can, with some confidence, now be added to the list of liquid–solid separation equipment that should be considered for a new operation.

Acknowledgements

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Reference

1. Viljoen, E. B., *et al.* The evaluation, design, and construction of the uranium plant for Chemwes Limited. *J. S. Afr. Inst. Min. Metall.*, vol. 81, no. 9. Sep. 1981. pp. 280–287.

Hydrocyclones

BHRA, the Fluid Engineering Centre, will hold its Second International Conference on Hydrocyclones at the University of Bath, England, from 19th to 21st September, 1984. Offers of papers are invited.

Hydrocyclones are widely used throughout the chemical, processing, mining, and water industries for liquid–solid and solid–solid separation. Recently, special cyclones were developed for the oil industry to separate oil and water, and to degas crude oils. The savings in weight and space offered by the use of this equipment are particularly important to platform operators, and have stimulated further interest in the technique. However, although hydrocyclones have no moving parts, the flow within the chamber is extremely complex. For example, designers and operators need to understand what effect changes in geometry have on the velocity distribution and turbulence within the hydrocyclone.

The meeting will cover all aspects of the theory, design, and development of hydrocyclones, as well as practical problems and applications. Prospective authors should submit titles and synopses of papers as soon as possible. Manuscripts will be required by March 1984.

Immediately prior to this meeting, BHRA will run an intensive two-day course for engineers wishing to familiarize themselves with the theory and practice of hydrocyclones. Registration for this course will be independent of the conference.

Offers of papers, and enquiries about the course, should be sent to the Organizer, Hydrocyclones, BHRA, Cranfield, Bedford MK43 OAJ, England; telephone (0234) 750422; telex 825059.