1. Crude dehydration using Alfa Laval's technology

Separation specialists
Systems for oil treatment are an important part of the Alfa Laval delivery program to the oil industry. They are the outcome of Alfa Laval's vast fund of experience in process and separation technologies to optimize process performance. That's why Alfa Laval can offer the optimal solution for treatment of the more difficult crude oils, where conventional techniques tend to fall short. Proper treatment can get troublesome crudes into specification and increase the capacity.

Solving an capacity problem
By treating the slop oil in Alfa Laval's centrifugal systems, with efficient separation up to 140 m^3/h per unit, capacity problems can very often be solved, chemical consumption can be minimised or eliminated and tank capacity can be released for more profitable use.

A difficult separation task
The nature and composition of heavy oil leads to a number of undesirable properties, such as its tendency to form stable emulsions in the presence of asphaltenes, particles and other emulsifiers occurring naturally in the oil. This, combined with a high viscosity and a relatively high content of solids, makes dehydration a challenging task that introduces new concerns when compared to light crude oil. As the density of the heavy oil increases and approaches that of water, conventional static and gravity-based separation systems become unacceptably large and require excessive heating and chemical addition to produce pipeline specification oil. Hence, the disc-stack centrifuge is an efficient solution in a compact size, enabling breakdown of stable emulsions and removal of dispersed water droplets and solid contaminants from heavy and viscous crudes, in both onshore and offshore installations.

Centrifugal separation – the key to successful production
In a high-speed disc-stack centrifuge, heavy crude oils with API gravity as low as 11.5° can be treated efficiently, to meet pipeline specifications without excessive chemical use. Heavy crude oil normally contains more solids than lighter crudes, as more solids are pulled from the formation due to its higher viscosity. Intermittently discharging centrifuges, previously supplied and quite common for crude oil dehydration, have a limited solids handling ability. With limited solids handling capacity, frequent discharges are necessary which can compromise a high production throughput. A centrifuge of the nozzle type, like X40 detailed in this quotation, can handle high solids contents, thus eliminating the disadvantages previously associated at times with high speed centrifugation.

Experience has shown that centrifugal separation in an Alfa Laval system is the most efficient and cost effective method for heavy crude oil dehydration. This is the result of special design features of the nozzle disc stack centrifuge employed with its short settling distances and the high g-force it develops. Depending on source and quality, each crude oil requires its own assessment for optimised capacity. A single centrifuge may suffice or a multi stage system may be necessary. Alfa Laval will tailor make the system that best suits your case.

2. X40 centrifuge system for crude dehydration

Equipment overview
The key component of the Alfa Laval **X40** system comprises a specifically designed high-speed nozzle bowl type disc stack centrifuge for crude oil treatment. The unit is presented in a functional modular form as a skid mounted package.

The package is intended to serve as the main separation stage, recovering the liquid oil to commercial specification. The function is to remove water and solids from the oil in order to achieve the desired specification.

Benefits of the system

The X40 offers a very economic cost / capacity relationship due to its high flow rate capability, feed composition flexibility and high quality on recovered oil. The installation is relatively simple, resulting in lower capital and integration costs.

The centrifuge is able to process effectively over a wide range of liquid characteristics and mixture compositions. Simple external control, with the patented **"Optiphaser"**, automatically adjusts to compensate for process variations, while in full production. Control of the treated fluid or product quality is instantaneous. The X40 can allow feeds with high, or variable, solids and water content to be easily processed, at all times giving the best achievable oil quality

5. Technical data

A typical GA-drawing representing the X40 system is enclosed in section 8 (Drawing No 1827405).

Utility Requirements

- Electric power, 3 phase 330 kW installed power for centrifuge motor.
  Single phase power for controls / instrumentation.
- 203.1-Hot Optiphaser water, (6-7 bar) at process temperature to supply centrifuge nozzle flow in low flow rate conditions (or low water cut in oil recovery version). Pumped and recycled water at up to 63 m^3/h (max nozzle flow). Separated water from process may be used (i e. recycled) for this purpose.
- 340-Backup water 72m3/hr at 2 bar head pressure.
- 510.1 Inert gas for purge of system (with inert gas blanketing option only) at 2 bar/purging at 1200 litres during purging just before before start-up, then approx 500l/h approx during operation.
- 502-Instrument air at minimum 6 bar (400 liters/min)
- 605.1-Fresh water for liquid seal, 40 50 l/h at 0.3 bar

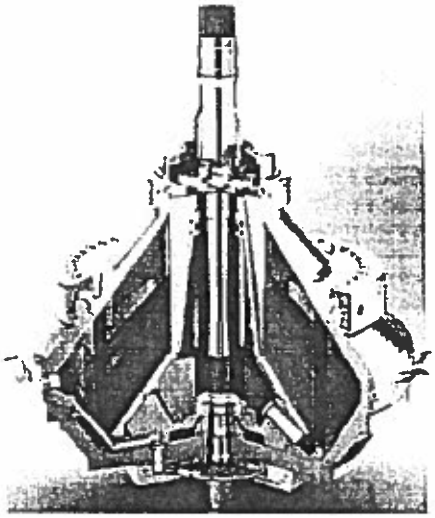
Skid weight and dimensions

Skid dry weight is 12,700 kg, and operating weight is 13,300 kg.

The overall dimensions are 4500mm long x 4400mm wide x 4200mm height with all equipment mounted.

6. Main flow description

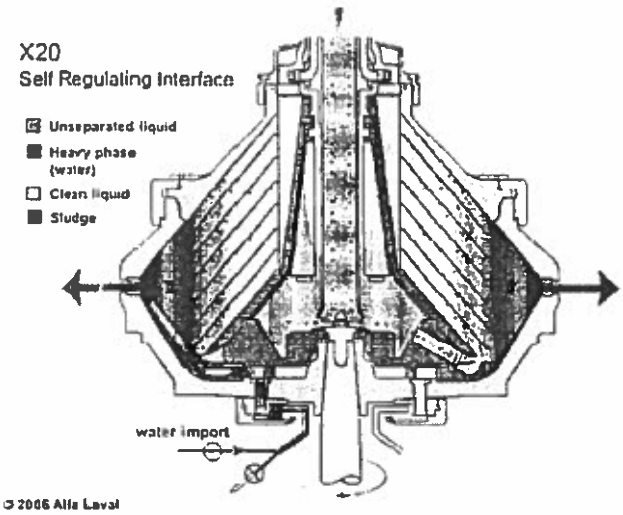
A typical P&ID representing the X20 complete system with inert gas is enclosed in section 7 (Drawing No. 1826341). Below is a simplified description to give an introduction to the centrifuge and the unique Optiphaser system.



The crude oil feed (grey) enters the X40 centrifuge by the feed pipe. When the crude oil enters into the centrifuge it will be distributed out to the disc stack where the actual separation takes place. The very high centrifugal force and the short settling distances in between the discs in the disc stack is what provides the excellent separation performance, even with difficult and stable emulsions.

The water (blue)and solids are slung out to the periphery of the centrifuge bowl (shown in more detail on the following page) and ejected through the nozzles into the water/sediment pipe.

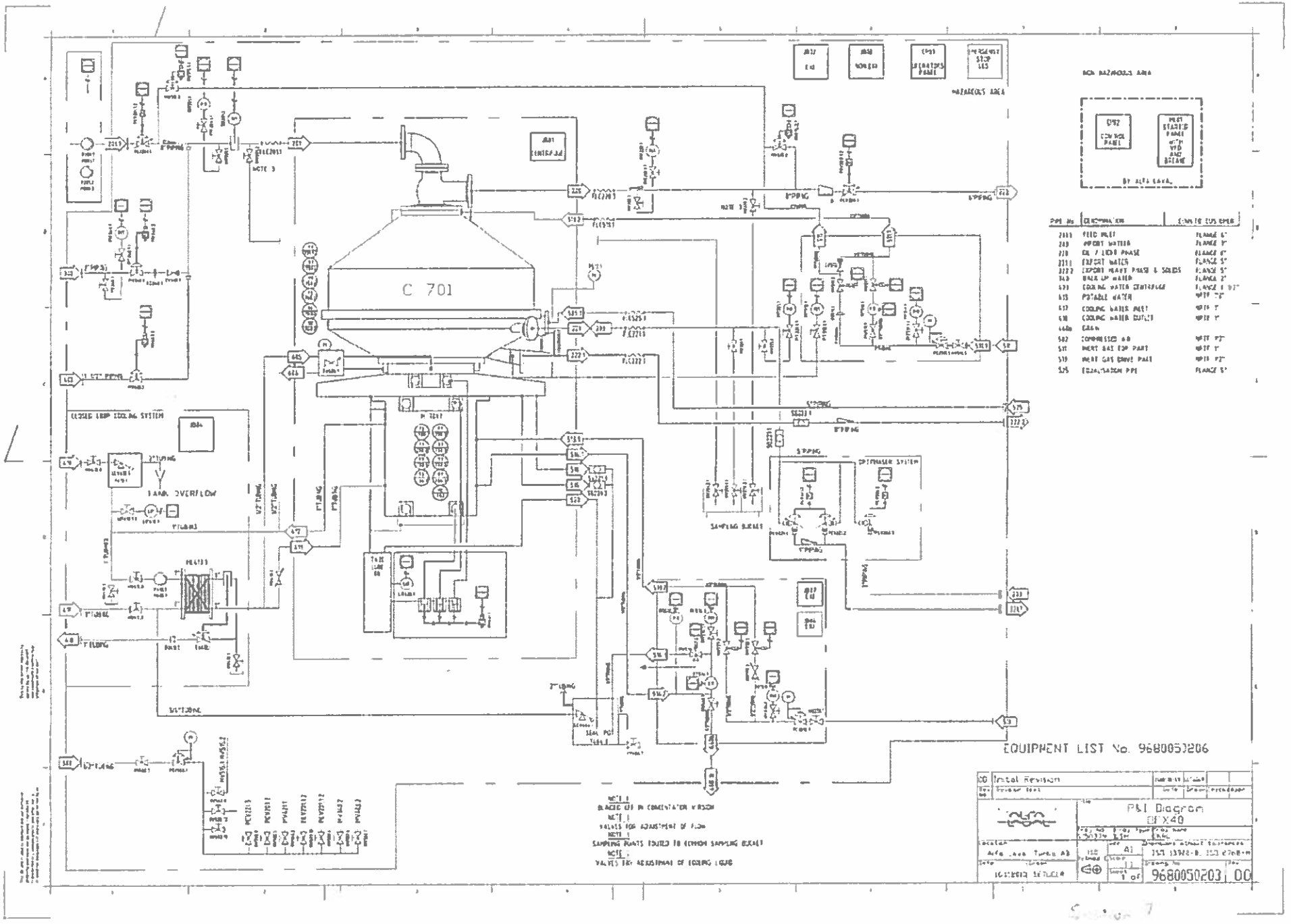
The dehydrated oil (yellow) is forced, displaced, into the centre of the bowl, and via a paring disc (pump device) in the top of the centrifuge bowl, pumped into the oil export pipe.



The principle of water/oil interface and Optiphaser balance system.

The balance of the oil/water interface inside the centrifuge bowl is important for constant and optimal quality of the crude oil. This is taken care of by the patented feature called **Optiphaser**. Without any use of a PLC or similar, the Optiphaser senses the pressure inside the centrifuge bowl, and will compensate for any difference in the water content in the feed by adding or removing as much water as necessary – automatically and at all times. The oil (and water) quality can easily be adjusted while in full production, by means of adjusting a simple air regulator.

Since the Optiphaser can totally compensate for water quantity in the feed, a further benefit is that the centrifuge can be allowed to run at any flow rate from zero to full flow. If the feed is low or totally shut off, the Optiphaser will import just enough water to satisfy the nozzle flow, which always is constant for any given nozzle size.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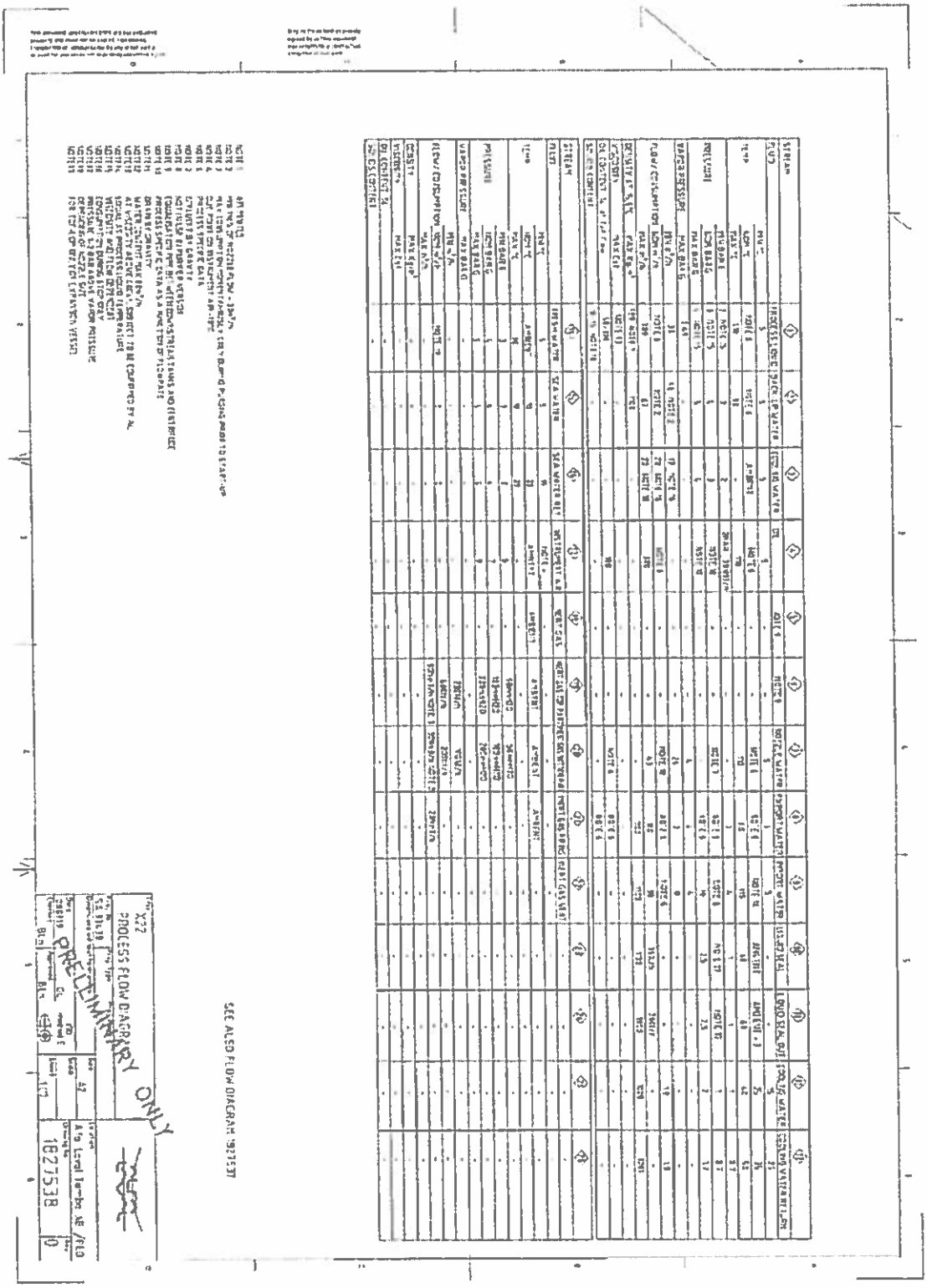
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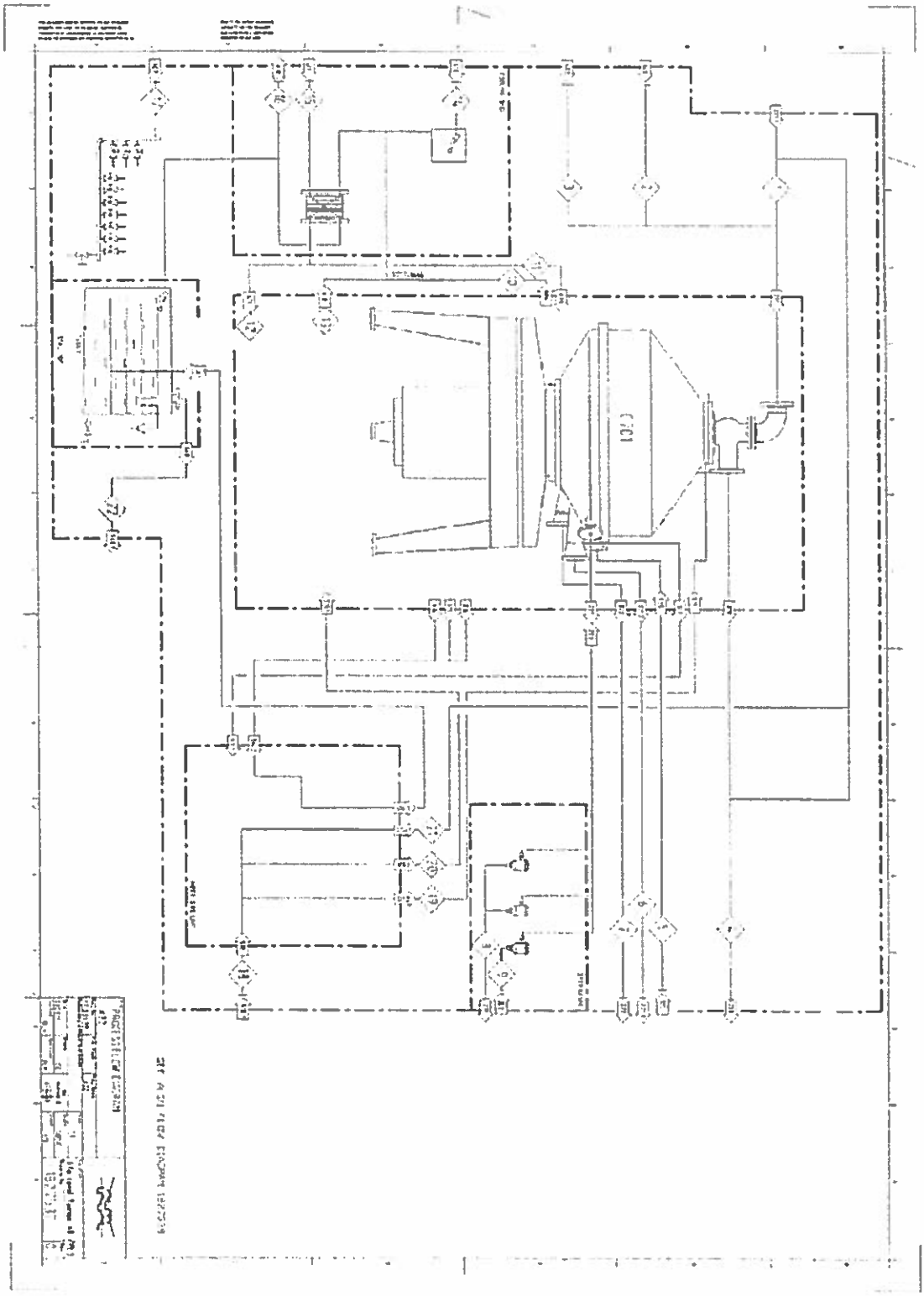

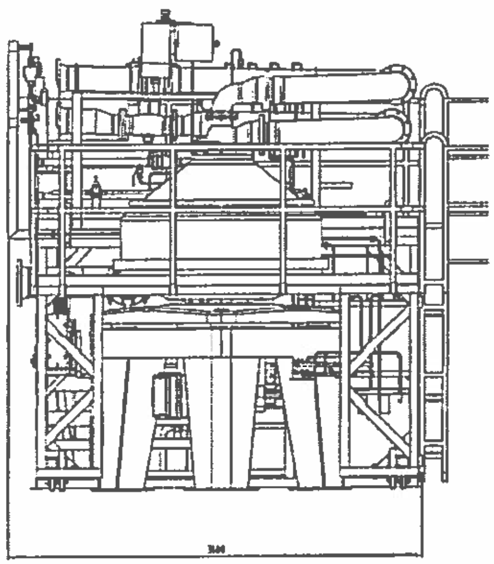

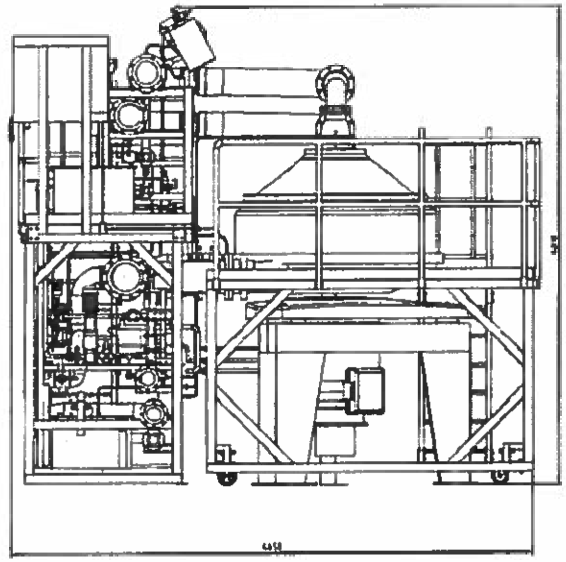

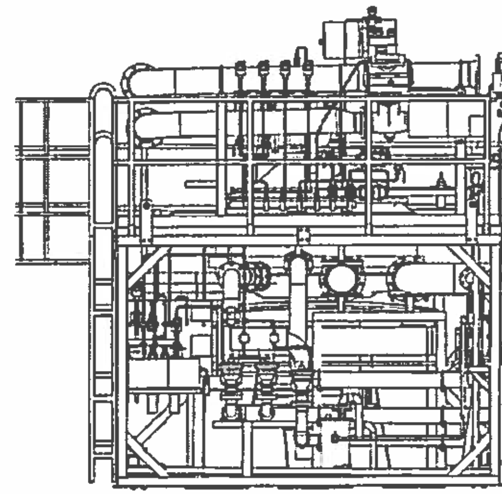

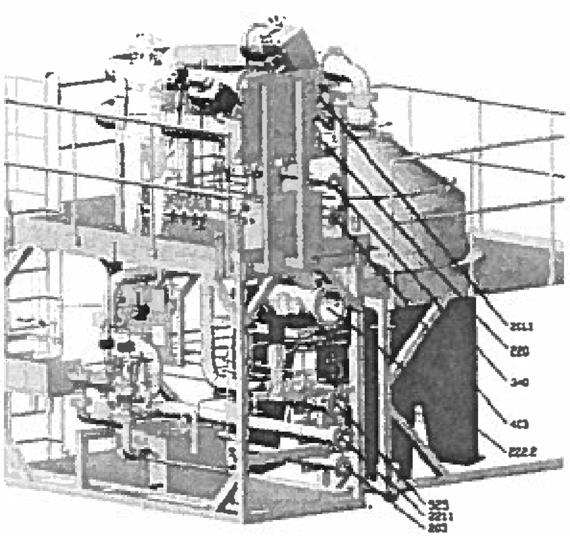

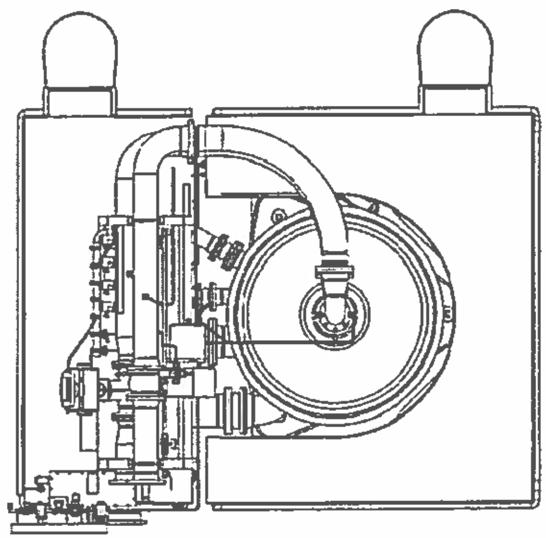

SEE ALSO DRWG.No
9680050203 P&ID
9680050206 EQUIPMENT LIST
9680050208 FOR NOZZLE LOCATION

CC Initial Revision	
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	SISO379
Location	ALfa Laval Tumba AB
	A1
	ISO 13920-B, ISO 2768-M
Sheet 1 of 1	9680050207 CO

Section 6

9. Process statement

Wet slop oil is generally a complex mixture and variable composition, often in some degree of emulsified form, i.e. small and stabilised oil droplets in water. The high g-force and short settling distance of disc stack centrifuges offers an unique possibility to separate the water form the crude, and the achievable performance is always a function of feed characteristics and flow rate.

Typical performance statement
As a professional company, Alfa Laval has a responsibility to supply system solutions that will reliably perform to your expectations. This typical performance statement is based on typical installation experience, however a full performance prediction or guarantee for a defined feed can only be provided based on test work (further below). As the market leading supplier of high speed separation solutions, our experience shows that proceeding in this manner provides the most mutually beneficial solution to your Slop oil treatment requirements. Based on our experience, the typical X40 performance on typical feed at 140 m^3/h of that flow rate water content of 90m3/hr would be handled by this system. Typical Performance would be as summarised in the table below.

Oil	BS&W < 0,5 % or expressed in more detail as:	
	Free oil content	99 - 99.9% by volume
	Free water content	0.1 - 1% by volume
	Sediment	Traces
Water	Free oil content	0 - 2% by volume
Sludge	Sludge oil content	Case specific

A typical feed for the plant is characterised by the table below.

Temperature	Maximum temperature for feeding the X40 unit +98°C
Free oil content	Minimum 50% by volume, maximum 100 % by volume
Oil density	Most and down to 11.5 API – see also comment below
Maximum viscosity (of petroleum phase in raw material)	Recommended maximum is 40 cSt during operation / higher values can be accommodated but may decrease separation performance unless flow rate is reduced
Wax in the oil	Possible wax present in the oil should be fully soluble at 70°C
Free water content	Maximum 50% by volume
Water density	Most – see comment below
Sediment content	15 m^3/h continuously higher amounts possible during peak periods
Sediment density	Minimum 1200 kg/m^3
pH	Within the range of 5 to 8
Salinity	Typically < 5%, but level dependant on temp, oxygen content and selected machine material, subject to confirmation case by case
Hydrogen sulfide	Typically 0 ppm, but up to 10 ppm in certain configurations, subject to confirmation case by case

Comment - Compared to most separators and technologies, the X20 design gives an extraordinary large operating window when it comes to densities and oil/water relations. To give a span for densities and oil/water flow rates can however be misleading, as their interrelationship gives a more accurate picture and the operating window for the unit. Operating outside this large window will influence the possibilities to regulate position of the interface, and will eventually affect performance. Contact AL for details, if the feed is expected to be significantly outside typical characteristics.

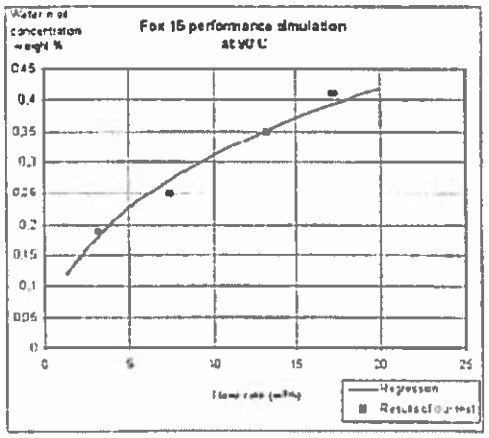
Test required for performance prediction
In cases where performance predictions are desired for a specific crude oil quality, AL has the ability to provide such a site/sample specific analysis. The analysis will help you in understanding the crude oil separation characteristics and the optimum process conditions, regardless of selection of supplier or final equipment. Important overall process parameters, like if pre-removal of solids is required, will be revealed.

Performance statement
If the properties of the feed are the same as per our test done on site in 2006, the X40 will achieve 0.5% BSW oil quality under the same conditions as tested.. As agreed, on receipt of PO, Alfa Laval will conduct a Hotspin test at site at no charge to CNRL to specifically run a test, determine the best operating conditions to meet these performance specifications..

The major benefit with such a test is the increased knowledge and prediction of the sample/site specific performance. The test is done through spin and lab testing of samples and a simulation of performance in the X20 is made as an addition. The detailed test report typically covers

1. Test objective
2. Method and separation description
3. Test results
4. Performance information

The addition of a performance prediction for the X20 is shown as an example below from a live, typical report based on a similar machine as the X20. The graphic outcome is a capacity/performance graph, and such a graph is a simple but valuable aid for setting up the optimum operation conditions. And as seen in graph, and typical for disc stack separators, a lower feed rate always dramatically improves separation and thereby oil quality. This is due to the increase in residence time, which helps in breaking emulsions further by removing even smaller water droplets from oil, as well as the smallest sediment particles.



The performance prediction from an AL analysis also serves as a basis for any negotiations of process gurantees, should it be required.