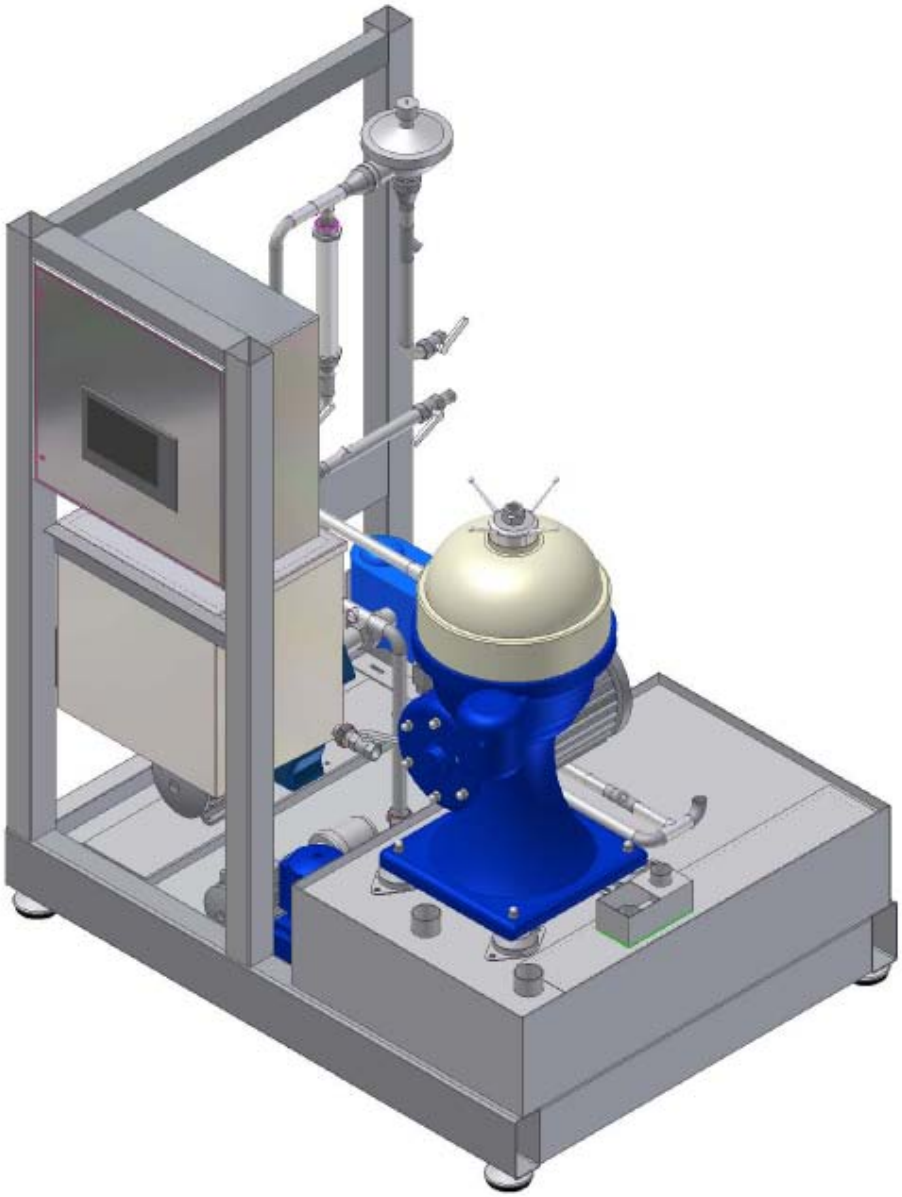
LUCENT OIL

TECHNICAL DESCRIPTION

UCO (Ultra Clean Oil) MODULE FOR OIL CLEANING



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Introduction

Polluting lube oils

Lubrication oils have a multitude of uses within industry. Common to these various uses is the fact that the oils, over time, become so polluted that they begin to affect negatively the processes they are intended to lubricate. Ideally, it should be possible for the same oil indefinitely and at the same time control level of pollutants and overall quality of the lube oil.

Conventional methods remove some of the pollutants, but they leave smaller particles as well as foreign liquids, both of which gradually accumulate in the oil. The challenge is to be able to remove even the smallest particles (< 5 µm) and all foreign liquids, such as water, before they can adversely affect the lube oil's inherent properties.

The traditional methods for accomplishing this involve using large filtration systems or sedimentation tanks. However, these methods result in large amounts of waste material that require proper disposal. Additionally, these traditional methods are inefficient and eventually lead to increased maintenance requirements.

Chemical and mechanical phase separation

The only way to continuously remove particles that are less than 5 µm and simultaneously remove any contaminating liquids is to combine chemical and mechanical separation methods.

The chemical two-phase separation is technology based on surface chemistry. The underlying principle is the ability to combine two liquids with one another and then have them separate into two phases (a top and bottom layer). For example, a two-phase system in a lube-oil system would involve mixing into the oil an insoluble additive with a higher density than the oil. Then, after allowing them to separate, a fluid bottom phase is formed and easily removed.

Via two-phase chemical separation, and relying on the principles of surface chemistry, it is possible to move macro-molecular or particles, i.e., soot with a lower density than oil, from one phase to the other.

Normal gravitational forces are sufficient for phase-separation in a two-phase system. The time needed for a phase separation normally varies from a matter of seconds to a number of hours – depending on the system's configuration. One method for dramatically decreasing the amount of time needed is to combine chemical separation with mechanical separation – such as a centrifuge with a so-called "high-speed" separator. By combining chemical and mechanical separation, the technology is able to overcome the limitations of mechanical separation.

The UCO Module

The System

The Ultra Clean Oil system, UCO, is specifically designed to efficiently separate and remove particles as small or even smaller than 1 µm in size from industrial oils, which is to say it is designed to return the oil to its original unused condition.

Schematically speaking, the UCO system is a module connected to an industrial oil collection tank. The UCO module is in a "by-pass" circulation from the oil tank and the pollutants are separated from the oil by adding a chemical-phase additive that effectively absorbs the contaminants (metal particles, carbon particles, water, etc.) and finally there is a mechanical separator.

The UCO module could be viewed as the machinery's kidney – cleansing the oil circulating through the system.

Technical description

Capacity

The UCO module can handle a flow in the range of from 500 l/hr up to 1500 l/hr. If a greater flow is required, then additional UCO modules may be coupled in parallel. The unit is designed to operate non-stop, 24 hours a day. The overall capacity depends on the oil's quality and the level of pollutant matter, plus what degree of cleanliness is being sought. Initially, the oils are usually so contaminated that a number of circulations through the module are needed in order to obtain the "steady-state" of cleanliness.

Separation additive

An Oil Treatment product (OT-product) is added to the lube oil in the UCO module, which is a two-phase additive. The OT-product is a chemical solution that is insoluble in oil and causes drops to form in the lube oil. These chemical drops absorb the pollutants in the oil since their surface affinity is higher than that of the particles and the surrounding lube oil. Because of the OT-product's higher density, it is easily separated and removed from the oil – together with the absorbed pollutants.

Physical and chemical data - OT-product

Form and color	Clear yellowish-brown liquid
Density (20ºC)	1000-1500 kg/m3
Viscosity (20ºC)	~480 cp
Flash point	>100 ºC
Solubility	Fully soluble in water and ethanol.

Module layout

For a diagram of the UCO Module, see figure 1 below.

The contaminated oil is pumped into the UCO module where a small amount of the OT-product is added. The oil and the additive are thoroughly mixed and then sent to the separator. Once in the separator, the heavier collection phase liquids containing the pollutants are separated out and the clean oil continues to a designated tank. Normally, the

clean oil is returned to the same tank with the contaminated oil, keeping the system uncomplicated.

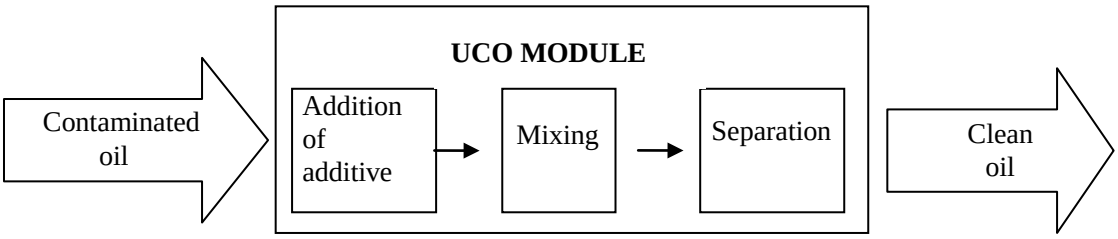

Figure 1 Schematic diagram of the UCO Module.

Technical data

Capacity:	max 1500 l/hr
Separation efficiency (particular):	< 1 µm, continuous
Chemical consumption:	100-500 ppm
Effect:	16 kW
Fuse:	25 A @ 400 V 50/60 Hz
Dimension:	l=1600, b=1200, h=2000 (mm)
Weight:	1200 kg

Results achieved with the UCO Module

The following results have been achieved with a UCO module used in an industrial setting:

- All unwanted matter in the oil was removed to a disposable sludge.
- Small quantities of sludge were generated, which contained only the OT-product and the pollutants.
- Overall productivity rose by up to 25 %.
- Reject rates were reduced by up to 80 %.
- There was a reduced need for maintenance of the machines and the tanks needed no cleaning.
- There was no need to dispose or replace the oil (system's oil in use for several years).
- The rolling mill's rollers have experienced less wear, and therefore have a longer lifespan.
- There has been a cleaner working environment for the operators and maintenance personnel.

Different types of lube-oil systems

Circulation of lube oil

Mineral oil is used in many situations with more or less the same goal – a reduction in friction between moving parts in machinery. Since the oil's task is to both lubricate and to disperse heat, the lube-oil system is most often in a circulatory system with a central oil tank, a pump, some sort of ventilation, and possibly an oil cooler, with it all connected via a pipe-line system to make circulation possible. Normally there is no lube oil consumed in the process because the oils are separated from the exterior surfaces of the machinery and is circulating in a closed circuit.

System tightness

A process or a machine being lubricated by oil can have varying degrees of tightness – from "totally tight" to fully open. In reality, totally tight systems do not exist because the requisite temperature exchange necessitates some venting to the surrounding environment to allow for expansion in the oil. One example of an almost totally tight system is a hydraulic oil system. Another is an oil-cooled high-tension transformer. Diesel motors are half-closed systems where the lube-oil systems must continuously be ventilated into the motor's own environment in order for the mechanical and combustion processes to properly function.

A totally open system is one such as a rolling mill, an example from the other end of the scale in terms of system tightness. This system lacks in any isolation from the process and the environment, and the oil come in direct contact with the machinery elements such as the steel being processed through the mill as well as the mill's rollers.

Polluting the oil

The degree to which the lube oil is polluted is a result of how much the oil is in contact with its surrounding environment. High pressure and high temperatures will also speed up the pollution process. Rolling mills represent the most exposed and problematic environment for a lube-oil system since the oil is in direct contact with untreated surfaces, and the oil is exposed fully to the surrounding environment and at the same time is exposed to extremely high pressure and temperatures during the deformation of the material in the rolling mill.

Separation efficiency

In order to reduce the chance for a lube-oil system to have a negative affect on a given process, the oil needs to be kept as clean as possible, i.e., free from pollutants. It is generally accepted that the separation efficiency of traditional cleaning systems is 100 % in terms of particles as small as 5 µm. However, for particles smaller than this the traditional cleaning systems experience a drastic reduction in efficiency. This is because it is not possible, in practice, to create channels or meshes small enough to catch and remove the pollutants. The lower limit for what practically works in a circulatory lube-oil system, without jeopardizing reliability because of blockage, is approximately 5 µm.

However, many of the unwanted particles found in a circulatory lube-oil system are much smaller than 1 µm. Therefore, the separation efficiency needs to be much greater than what in practice is being achieved.

The oil's lifespan

Polluting particles caused by the machine's processes will remain in the oil until they are removed by a cleaning system. The presence of these pollutants can lead to various mechanical problems or, in the worst case, breakdowns in the machinery. In order to avoid this, the operator must from time to time dispose of the oil and replace it with new. The accumulation of sub-micron particles in the oil results in changes to the oil basic properties – viscosity, bearing capacity and lubricant quality. If these sub-micron particles were being continuously removed from the oil, then the mineral oil's lifespan would be unlimited.

Blackening of the Oil

The sub-micron particles, together with the soot particles smaller than 1 micrometer, give used lube oil its familiar black color, and even if there is a cleaning mechanism within the circulatory lube-oil system the oil will still be black. The ideal cleaning system for lube oils would take away the black color produced by these sub-micron particles and return the oil to its original golden color and transparency.

Filters and pollutants

The traditional method, used extensively within industry, for achieving a higher degree of cleanliness in lube oils has involved the use of "pre-coat filters", i.e., a filter system with an extra filtering agent that produces a mesh with smaller openings that what is attainable with a mechanical filter. The filtering agent can be anything from cellulose fibres to pulverized seashells. However, once these filtering agents are saturated with pollutants they have to be removed from the filtration system and then new quantities of the pre-coat agent placed in the filter. This filtration method generates considerable amounts of oily waste products – waste containing relatively small amounts of the pollutants in comparison to the amount of filtering materials requiring proper disposal. In order to remove a single litre of wet contaminant particles from the machinery's oil flow involves the production of thousands of litres of oil-fouled filtering agents.

Of even greater concern is the fact the pre-coat filtering agents themselves disperse contaminating particles into the "cleaned" oil. This is because of variations in the pressure at a pre-coat filter and because it is not possible to construct a totally flow-symmetrical filter. These particles can actually cause more damage to the machinery than the normally occurring particles.

The end result may be that the net amount of pollutants is only a small fraction of the amount of particles that the filter itself is generating. This is the primary construction criteria for a system for Ultra Cleaning Oil i.e., to pay attention on the net amount of pollutants and to remove them from the oils.