JISKOOT™ QUALITY SYSTEMS

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In-Line Lube Oil Dehydration

A method employed by Mobil Oil

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A frequent problem encountered in the process of lube-oil blending is the existence of water in the base stocks. This may be present in dissolved or entrained quantities and must be removed in order to avoid "clouding" of the final blended product.

Generally speaking, lube-oil dehydration is required over a moisture content range from .05 to .001 percent (or better) w/w. A presence of water in excess of .05 percent can usually be reduced to this value by normal stratification methods.

There are various types of analysers to ascertain water in oil contents, however, the most frequently used method is the very simple "crackle" test. This consists of heating a sample of oil over a burner which will cause any entrained or dissolved water to escape in the form of an audible crackle noise. This test is good for a detection of down to 8 parts per million.

This simple heating method is not acceptable as a large scale dehydration method, since many lube oil base stocks can be "damaged" by heating in excess of 170-180° F. It is this reason which caused initial development of lube oil in-line dehydrating equipment to follow the path of "flash evaporation", under partial vacuum. In this system, heated oil is introduced as a very fine film in to a vacuum chamber. This method whilst very successful has a high capex as well as opex cost.

The Jiskoot in-line lube oil dehydrator is a development of the commonly used batch dehydration methods in which a tank of heated oil is "blown" for several hours. The Jiskoot dehydrator requires heat and air; normal ambient air.

Principles of operation

Oil is supplied to the dehydrator at a constant pre-determined pressure. This passes through the heat exchanger and then is fed to one or more specially designed ejector nozzles.

Ejectors and their nozzles were specially developed for their purpose in which the release of kinetic energy creates a partial vacuum of such value, that large amounts of air are drawn in and finely interspersed with the heated oil. The large contact area created by this process (in the extra long diffuser) induces a rise in air temperature with a consequent steep rise in "moisture absorption-ability" of the air.

The air/oil ratio obtained is such that the prevailing humidity has no effect upon the efficiency of the unit.

The resultant air/oil mixture is collected in a fibreglass bath fitted inside the fully enclosed dehydrator receiver. Suitable baffles and primary screening facilities allow the excess air to be exhausted immediately to atmosphere. The heavily aerated oil is subsequently passed through a "de-aerating" section at a low velocity. Various screens of different meshes at different angles will ensure the effective release of entrained air from the oil before the final dehydrated product enters the discharge pump.

Humidity

The question that immediately comes up is the one revolving around "humidity",e.g., will it work, for instance, on a wet rainy day?

Normal air is only partly saturated with moisture vapour and further raising its temperature increases its capacity for absorbing vapour. This unsaturation of the air may be satisfied by exposing it to water. It is also a fact that air saturated with moisture will deposit liquid water if cooled. Thus in this method, whilst moisture is absorbed from the oil by heated air, the degree of saturation must not rise to such an extent as to produce re-depositation of the water as the air cools on leaving the hot oil.

An extract from psychrometric charts follows, to illustrate the capacity of air to absorb moisture; shown in lbs of water per lb of air.

Table I

Ambient			Relative Humidity				
Air Temp	10%	20	30	40	50	60	100
40°F	0.001	—	—	0.002	0.003	0.0045	0.005
50	0.0015	—	—	—	0.004	—	0.0075
60	—	—	—	0.003	0.005	0.0065	0.011
70	—	—	—	—	0.0055	—	—
100	—	—	—	0.017	0.021	0.025	—
120	0.0075	0.015	0.022	0.030	0.038	0.046	0.087
140	0.012	0.025	0.039	0.053	0.068	0.084	—
160	0.021	—	—	0.094	—	—	—

In Table II the dewpoint is shown for varying degrees of saturation at various temperatures.

Table II

			Relative Humidity			
Temperature	10%	20	30	40	50	60
40°F	—	—	14°F	—	—	28
60	—	—	—	36	—	46
100	34	—	63	—	78	83
120	—	68	—	—	96	—
140	63	84	97	106	—	—
160	78	—	—	124	—	—

As an example, air on a cool day at 50°F and 50 percent RH containing 0.004 lb water per lb of air, can be heated to 140°F/10 percent RH (Table I) and contain 0.012 lb, lb-a gain of 0.008 lb/lb. This air may then be cooled to 63°F (Table II) before re-depositing moisture.

Carrying the earlier example a stage further, we may assume an oil with a water content of 0.05 percent which is in contact with the original 50°F/50 percent air, now heated. Each lb of oil contains 0.005 lb water, so that only 1/16 of a lb of air is needed to absorb this moisture and still stay within the dewpoint restriction. This weight of air corresponds to a little under 1 cu ft at 60°F and the weight of oil to 1/36 of a cu ft, giving an oil/air ratio of 1:50 in volume.

Temperature

Approximate specific heat of oil is 0.42. The Approximate specific heat of air = 0.25. The cool air mixing with the warm oil will lower its temperature. Extending our example a ratio of 1:50 oil/air by volume is 1:1/16 th by weight. By heat balance at equilibrium, the oil will be cooled from 140°F to 133°F, and the air heated from 50°F to 133°F. From this latter temperature the air will cool as it escapes from the oil, the rate of cooling depending on the actual design of the equipment.

Experience

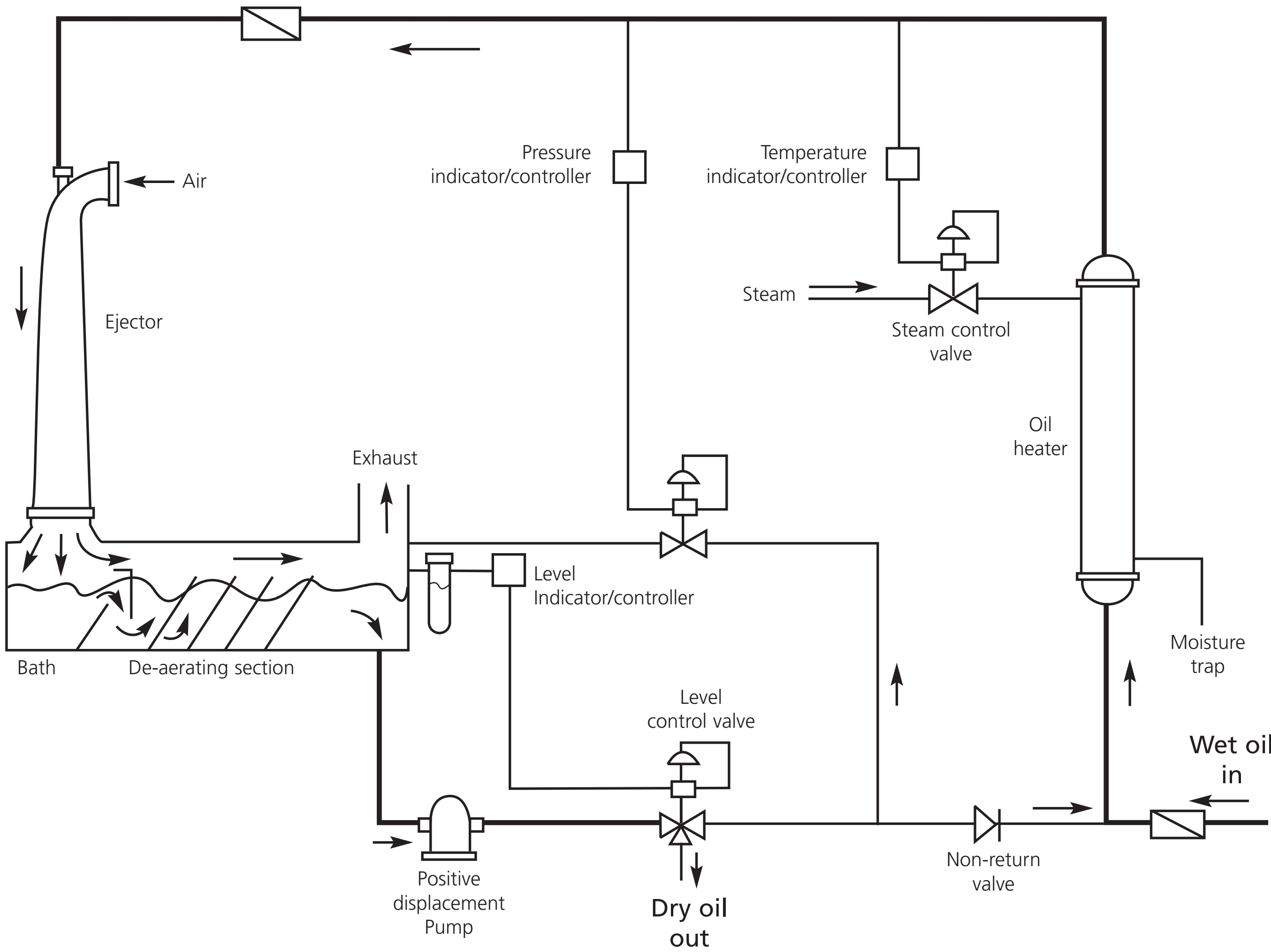
Suitable trials were carried out some years ago at the Mobil Oil Works at Wandsworth and these were very encouraging. As a result of these experiments, Mobil ordered one unit for a throughput of 200 g.p.m (740 m^3/hr) for their Birkenhead Works.

This installation (illustrated) has now been in operation successfully for many years.

Very "wet" oils have been dehydrated to pass the "crackle" test by feeding the dehydrator at 50 to 60 percent of its maximum flow rate, thus obtaining a recycle or two-stage dehydrating effect. Initially, problems were encountered with heavy foaming, due to ineffective de-aeration. The enlargement of that section reduced the flow velocity and improved matters considerably. As most base stocks and blended products are initially discharged into buffer or hold tanks, the 20 seconds or so required for the heaviest oils to clear, produces no serious problems. It was also found necessary to install an extraction system for the vapours emanating from the dehydrator. This was particularly desirable in view of the fact that the unit operated within an enclosed building.

Another incidental, but very interesting advantage, is that it is no longer essential to dehydrate slightly wet base stocks before the introduction of additives. If an in-line blender is used, followed by a dehydrator, blended products will always come out clear and bright, due to the fact that the "delicate" type of additive had insufficient time to cloud the product.

Basic schematic diagram of Jiskoot lube oil dehydrator



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