Mohr Separations Research, Inc.

Field Test Case Study and Process Recommendations for a Large Machining Facility

Machine Tool Coolant Purification Separator

Contents:

Appendix:

Mohr Separations Research, Inc.

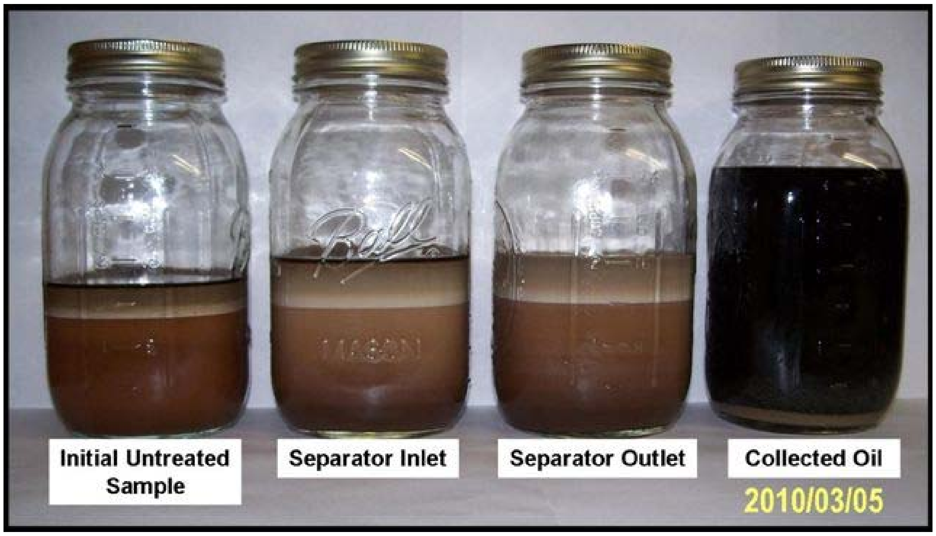
Field Test Case Study and Process Recommendations for a Large Machining Facility

Machine Tool Coolant Purification Separator

Executive Summary:

Field testing was completed to prove the process in separating oil from machine tool coolant at a large machining facility in Arlington, Tx. The test separator overall process is working well and separating large quantities (relative to the size of the separator) of oil from the coolant. The samples taken indicate that substantial amounts of oil are present in the coolant. The photo below shows the difference between the separator inlet and outlet oil content and also the captured oil. While it is difficult to photograph, the absence of an oil layer in the treated sample indicates very effective removal.

The results of the test indicate that the separation is very satisfactory, but the test separator is too small to adequately purify and maintain purity of the volume of coolant in this large size coolant tank (6000 gallons or 22,700 liters). A much larger size Model MSR 34-1 separator is suggested to remove the current inventory of oil in the coolant and prevent future accumulation of oil by removing it as it enters the coolant system.



A drawing of the test system is attached.

Field Test Results:

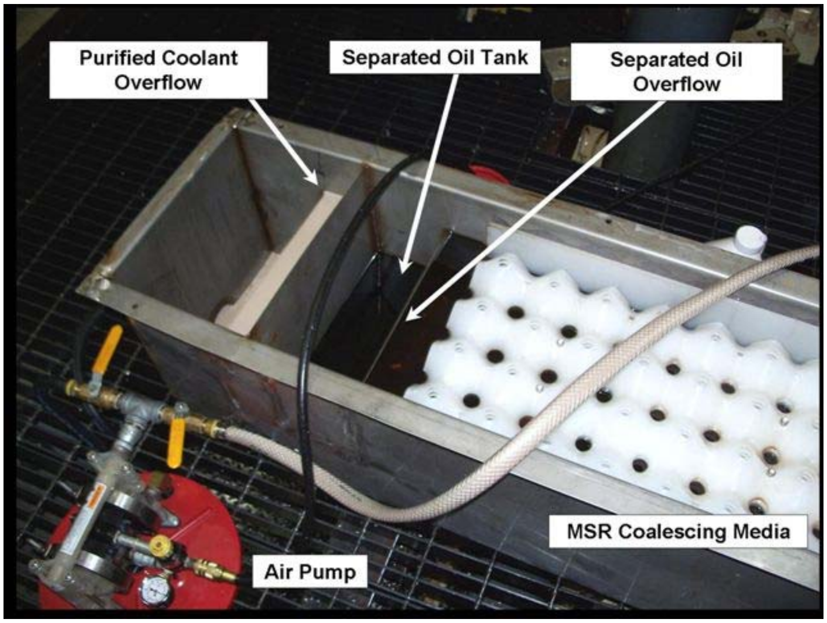
Field testing was completed at the machining facilities on one of the coolant tank systems (6000 gallon or 22,700 liter capacity) to determine the effectiveness of the coalescing plate separator system in removing tramp oil from the coolant. MSR's generic MSR-11 separator was used for the testing.

A sample was taken of the initial coolant in the system. This sample was allowed to settle for about two weeks, and a layer of oil formed of about 1/16". The coolant layer thickness was about 2.75 inches. This indicates that a rough estimate of the coolant oil content would be about 60,000 parts per million oil. Based on a 6000 gallon tank, this would indicate an oil inventory in the tank of about 363 gallons. While this is probably a very high estimate, it certainly indicates that there is a substantial amount of oil present in the coolant.

The MSR test separator was set up utilizing a very small positive displacement (air diaphragm) type pump, with the pump taking liquid coolant / tramp oil mixture from the separator and returning processed coolant to the sump.

The system was filled with coolant utilizing the pump and in a short amount of time began to show a layer of separated oil in the inlet end of the system. This layer built up and eventually overflowed into the oil holding tank.

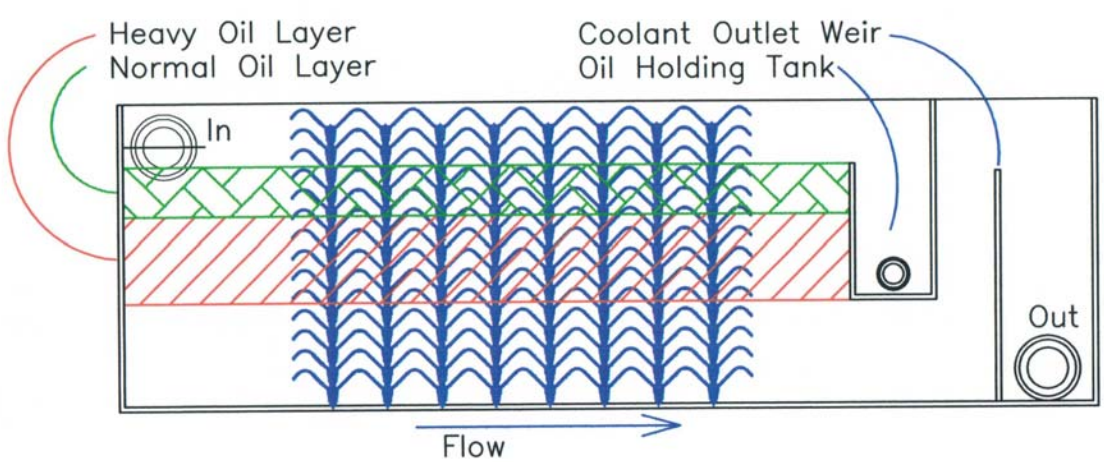
The purified coolant flowed under the oil tank and out of the system over the overflow weir. The photo below shows the contrast between the very dark brown upstream (oily) side of the system and the beige-colored cleaned coolant side (at left of photo).



Eventually enough oil built up in the front of the system to begin flowing under the oil tank and appeared in the outlet end overflow. It was suspected that the captured oil was of much higher density than is encountered in most facilities. Subsequent testing indicated that the specific gravity of the captured oil is 0.93, consistent with a very heavy lubricating oil. The coolant specific gravity was found to be approximately 0.99.

The oil flowing under the oil tank occurred because the generic MSR-11 system is not designed for continuous separation of oil of 0.93 specific gravity and it built *down* much more than is common. When the specific gravity is 0.93, 93% of the oil will displace water (building down) and 7% will float above the normal water level.

The sketch below shows graphically the oil capture situation and why the oil passed under the oil tank.



Other than this problem the testing was very successful and indicates a very high probability of success in a commercial unit.

Design Basis

General:

It is intended to remove oil droplets to the smallest size practicable to improve coolant performance and extend coolant life. Removal of the oil also removes substrate for possible bacterial action and reduces the bacteria and can also reduce requirements for bacteriacide and / or anti-foams chemicals.

MSR suggests that the best way to improve oil removal in the system is to provide a coalescing plate module type separator. As the coolant-tramp oil mixture enters the coalescing modules, the droplets will rise within the flow according to Stokes's Law and meet the undersides of the plates. The separated oil will coalesce on the undersides of the plates and flow up along the surfaces, eventually rising to the surface of the water, where it will form a layer on the surface of the coolant.

A more detailed discussion of the operations of the coalescing plate system can be found in "How They Work", available on request.

Design Parameters Chosen:

Design Flow:

The system will be designed to operate on a stream of coolant of which the maximum instantaneous flow for the separator has been estimated to be 10 US gallons per minute. This flow was chosen based on our experience with coolant systems and the results of the testing. Calculations were completed at this flow rate. This flow is assumed to be water contaminated with a relatively heavy lubricating oil mixture.

Design Water Temperature: 72 degrees F. This is a reasonable temperature for coolant equipment and matches the temperature measured during the test. At higher temperatures, separation would be improved.

Design Oil Specific Gravity: 0.93. This is consistent with the properties of a lubricating oil mixture and matches the collected oil specific gravity measured at the site.

Design Oil Concentration: 60000 mg/l (ppm) This was chosen because the initial sample was allowed to settle and the coolant and oil layers were measured. This is probably not a very accurate method of estimating the oil content, but sufficiently accurate for purposes of this study. *Please note this indicates that in the 6000 gallon tank system approximately 360 gallons of oil are entrained in the coolant.*

Design Average Inlet Oil Droplet size: 140 micrometers (microns). This was chosen as size consistent with the 60000 mg/l estimated inlet concentration and operating conditions.

Coalescing Plate Configuration: Two coalescing plate configurations are available – nominal ¼" space and nominal ½" space. The narrow spacing was chosen for this application because it is more efficient on a per cubic foot of media basis, and since the process conditions are not well defined it is wise to choose the most efficient.

Process simulation calculations:

A configuration was chosen utilizing a 304 Stainless Steel separator tank equipped with twelve modules of coalescing media, arranged in one row consisting of three stacks of four modules. Please refer to the drawing attached for depiction of the process flows.

Based on the information provided and the assumptions discussed above, process simulation calculations for oil removal were prepared. These calculations (copy attached) indicate that, at the conditions shown above, the expected effluent will be less than 20 mg/l although the effluent from a single pass is not as important as the overall removal.

Please note that the system is designed to remove droplets down to about 18 microns (micrometers) in diameter and separate 90+% of the oil. The process simulation program predicts 100% removal, but the inherent assumption in the program is a log-normal droplet size distribution and I expect that there are more small droplets than the program is expecting.

Operations:

It is suggested that the system be operated for several months at the design flow rate and then the flow be reduced to about 3 gpm and operated more or less continuously to keep the oil content of the coolant inventory down. The reason this is suggested is that at lower flow rates the system is more efficient and removes smaller droplets. By operating at the higher flow for some time, all of the large droplets will be removed in a relatively short amount of time and then by operating at the lower flow rates all of the small droplets will be removed as well.

It is not possible to predict the final cleanliness of the coolant because there are probably very small droplets that are very difficult to remove. We do not have any way of predicting the percent of the oil that is present in these very small droplets, but we know that the large majority of the volume of the oil is present in the larger droplets (bigger than 20 microns) and these will all be removed.

It should be pointed out that 40 microns is about the smallest droplet that can be seen by the human eye, and the volume of a droplet is proportional to the cube of the diameter, so an 18 micron droplet contains only about 9% of the volume of a 40 micron droplet. The result of capturing these small droplets is very, very good capture of the oil.

Service:

In general, no service is expected to be required for the use of the separator except for removing the oil occasionally and cleaning when large amounts of solids have been collected. The cleaning frequency will vary with the amount of solids present in the water and the amount of use of the separator.

Conclusions and Recommendations:

The process study discussed above indicates that a MSR coalescing plate separator should do an excellent job of recovering almost all of the oil droplets and solids particles within the flow stream. Since little or no maintenance is required for this type unit and no utilities are required, operating costs should be very minimal.

Safety is always a concern in industrial facilities. It is the responsibility of the owner to assure that appropriate safety procedures are in place and followed. Because the system proposed is a passive gravity-operated system, little maintenance or other attention is required and there are no electrical or high speed parts that may fail and cause personnel hazards.