

What cause Cavitations and Air Bobbles – and how can they be removed?

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"We have six 6-MW diesel generator sets to meet the power requirement of our cement plant. We are facing cavitations problems in the lubricating oil gear pumps. The damage occurs to both the housing and gear surfaces. This results in only 8,000 hours of service life, which is too low. What are the possible reasons for gear pump cavitations?"

The above question has been raised at an online discussion forum. We at Ocean Team have been meeting similar questions from our customers. The purpose of this article is therefore to put forward our knowledge and experience within this matter and further give our recommendations to, how the challenges can be solved.

What cause Cavitations and Air Bobbles?

Several different circumstances can cause formation of cavitations and air bobbles in technical systems. Among some of the most common sources are listed below:

- **Tank design issues**
 - turbulence in the tank churns the air into the oil or simply doesn't allow air to be released from the oil. This can be caused by plunging oil returns, low oil level, a tank that is too small, lack of proper baffling, etc.
- **Suction-line leaks**
 - leaks between the tank and the pump can introduce air. Often this is associated with the shaft seal at the pump that allows air to leak in.
- **Suction-line restriction**
 - sometimes suction lines are too long, too narrow or they are simply plugged (e.g., a plugged suction strainer).
- **Insufficient head**
 - depending on oil viscosity and suction line conditions, the pump must be located at a sufficiently low elevation to enable oil to flow readily from the tank to the inlet port of the pump.
- **Air release problems**
 - as oils age and become contaminated, air release properties become impaired. This simply means that once air bubbles form they stay locked into the matrix of the oil and don't de-

train out of the oil in the reservoir. Moisture contamination and oxidation are known precursors to this problem, among many others. ASTM D3427 is a test for air release properties.

- **Water vapor**
 - when hot oils become contaminated with water, superheated steam will form vapor bubbles in the oil.
- **High viscosity**
 - when reservoir temperatures are too cold, during wintertime startup conditions for example, the viscosity may be too high to enable proper oil flow in the suction line and into the pump. Other causes of high oil viscosity can lead to the same problem.

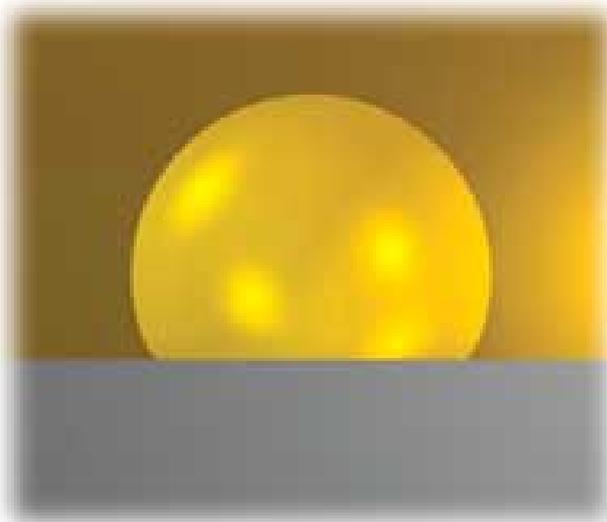
The Consequences of Cavitations

In addition, cavitations may result in increased oil oxidation rates. When an air-ignitable mixture is present within the bubble, ignition may occur from the rise in temperature accompanying the compression process. This process requires only nanoseconds and the localized temperature may be 2,012°F (1,100°C) or higher.

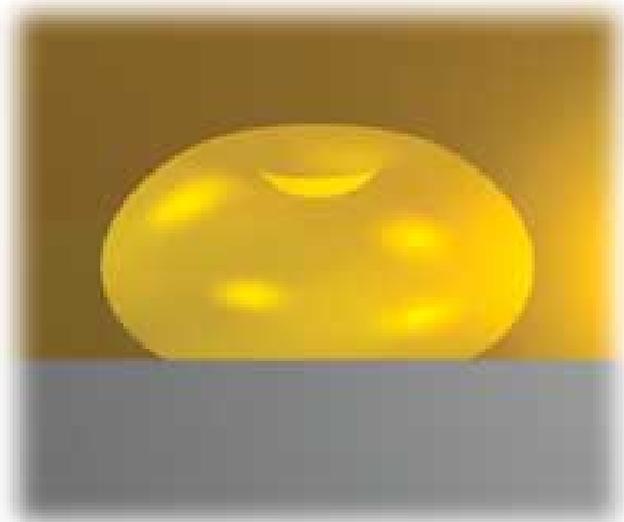
The process, also known as the micro-dieseling effect may lead to oxidative degradation of the hydraulic oil, localized hot spots and pressure spikes, and may subsequently lead to cavitations erosion in a hydraulic pump or other component. In addition to these well-known processes, cavitations may lead to the formation of reactive chemical intermediates, which are capable of affecting secondary oxidation and reduction processes.

These and other hydraulic and lubricating system problems resulting from the presence of bubbles in a hydraulic fluid include:

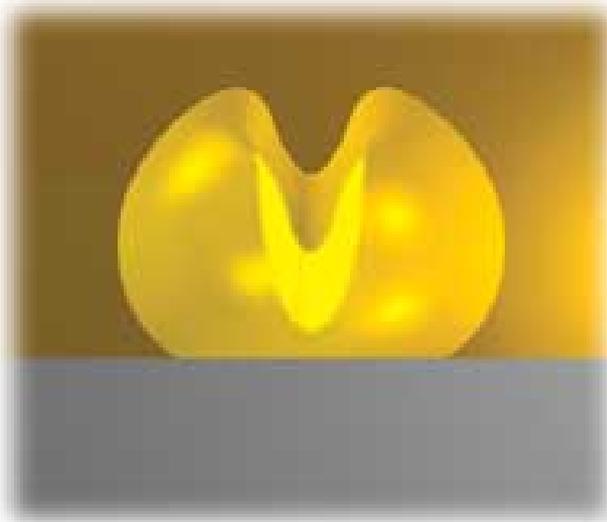
- Oil temperature rise
- Deterioration of oil quality
- Degradation of lubrication (due to either viscosity loss or sludge and varnish formation)
- Reduced thermal conductivity
- Cavitations and erosion
- Noise generation
- Reduced bulk modulus (due to fluid aeration leading to a spongy fluid and sluggish system control)
- Decreased pump efficiency
- Reduced dielectric properties



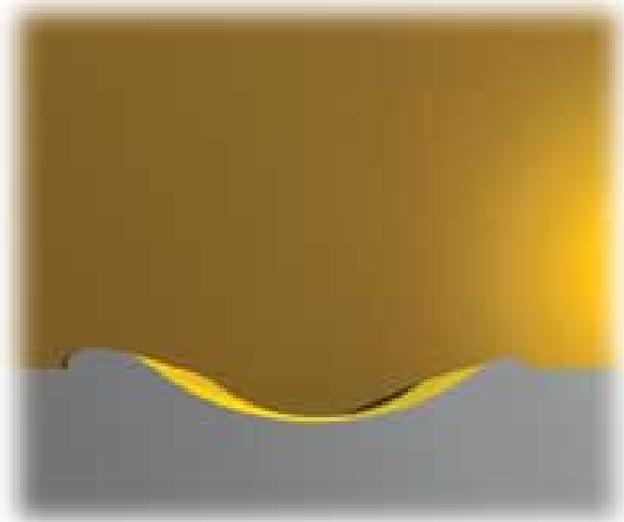
Initial Bubble



Initiation of Bubble Collapse



Forming of Liquid Jet



Impact and Metal Extrusion

Figure 1 - Cavitation Damage.

Conclusions

Cavitations and air bobbles can have several root causes. Some relate to system and component design issues and others are more service related. Cavitations occur when either air or vapor bubbles form in the suction line fluid and are subsequently imploded in the pump by the pressured oil. This leads to micro-jets of oil pounding and eroding adjacent surfaces which reduce the service life of the oil and increase the maintenance cost essential.

In the light of the above punch list of possible contributing causes of cavitations Ocean Team experience that most cavitations and air bobbles issues is mainly

caused by a chemical reaction into the oil due to the fact of:

1. Air release problems. As oils age and become contaminated air release properties become impaired. (Oil degradation) This simply means that once air bubbles form they stay locked into the matrix of the oil and don't de-train out of the oil in the reservoir. Moisture contamination and oxidation are known precursors to this problem, among many others. ASTM D3427 is a test for air release properties.



2. Water vapor. When hot oils become contaminated with water, superheated steam will form vapor bubbles in the oil. (Oil degradation)
3. System design issues or clogged pump suction filters.

Recommended solutions

Ocean Team has many years of experience with solving fluid problems in technical systems. We are leading in providing 'Total Purity Solutions' and specialists in solving the unique challenge of the individual customer.

In our world, no jobs are identical – there will always appear variations in both the definition of the job, the sources causing the challenge, the extent of consequences, the technical system and/or precautions to be taking into account. Different needs and challenges do also require different solutions.

Our recommended solutions for removal of cavitations and air bobbles must therefore be seen as an example of which actions we would apply in order to solve your challenges. Our recommendations are:

1) Oil degradation

- I. Take out representative dynamic oil sampling from live lubrication system.
- II. Send the sampling to Ocean Team for a full spectrum analysis including additive package together with a sampling of the new lubricating oil as the reference for comparison.
- III. The spectrum analysis report will include an evaluation of oil degradation and a solution will be discussed with the customer.
- IV. Ocean Team's experiences is that very common/often it is necessary to provide a lube oil flushing with turbulent flow velocity higher than $RE > 3000$ of the lubrication oil system to remove contamination and water to stop the negative chemical reaction leading to oxidation, varnish, high temperature, low viscosity

and low flash point. Ocean Team can provide this successfully oil flushing and in some cases we are able to provide this service without any production lost.

- V. After oil flushing, Ocean Team is able to implement a necessary "Ocean Team OilCare Program" including periodical trend oil analysis and installation of an oil-purification systems for preventive maintenance of the oil and lubricating system which enhances the oil quality, restores the lubricating oil viscosity, augments the flash point and improve operational performance and finally secure you a safety and money saving continues operations.

2) System design issues or clogged pump suction filters.

- I. Check with machine suppliers for specifications and check for lack of same. Ocean Team is able to assist you by implement the machine supplier's requirements and recommendations.

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