Troubleshooting Leak/Solution Chemistry Related Problems

General

The procedures in this letter will provide the technician with a methodical approach to solving solution chemistry / leak related problems on YORK absorption chillers. The goal is to eliminate unnecessary leak testing.

Required Tools and Materials

- Solution Sample Kit (028-15065-000 – Qnty. 12) – each kit contains instructions, two sample bottles, filter paper, log form and shipping box.
- 2.5 – 5 gallon plastic bucket
- 100 ml graduated cylinder
- Hydrometer (SG 1.4-1.6)
- Spindle valve adapter

Additional Tools and Materials If Leak Testing Is Required

- Applicable leak testing equipment necessary to perform one or more of the following tests (soap bubble, refrigerant, helium), Refer to appropriate leak testing standard.
- Tracer gas (nitrogen, R-22, Helium)

Background -

The following information will help you successfully troubleshoot a chemistry and/or leak problem on YORK absorption chillers. This methodology can also be used to troubleshoot any absorption unit using the inhibitors discussed.

Inhibitor Types Covered: Lithium Chromate (Li_2CrO_4),
Lithium Nitrate ($LiNO_3$),
Lithium Molybdate (Li_2MoO_4) and,
Advaguard 750™

Advaguard 750™ inhibitor is presently used in all ParaFlow™ and IsoFlow™ absorption chillers. The same formulation is used in both chiller types.

Corrosion Protection Mechanism

Inhibitors help to promote the formation of a protective iron oxide film on the inside steel surfaces of the vessel. This protective film is referred to as magnetite (Fe_3O_4). This oxide layer, not the actual inhibitor, helps to reduce corrosion rates in a machine. In order to successfully troubleshoot a solution chemistry related issue on an absorption unit, it is necessary to have an understanding of the various types of inhibitors used and their benefits and shortcomings.

Inhibitor Types

Lithium Chromate (Li_2CrO_4)
Used for years on YORK single stage machines only, Chromate inhibitor offers outstanding protection for both ferrous and non-ferrous (i.e. copper, cupronickel, etc.) metals. The only shortcoming of chromate is that it is toxic and needs to be handled as such. The quantity of inhibitor present in the machine can be tested using a YORK test kit (part number 026-18304-000). It is more accurate, however, to send a sample to a lab for analysis. This is the only inhibitor whose concentration can be tested in the field. It is important to note that chromate has a distinct yellow color. If a sample is removed from a chromate inhibited chiller and it appears to be clear, this is a sign that little, if any, inhibitor is present in the unit.

Lithium Nitrate ($LiNO_3$)
Lithium nitrate is used on most older YORK and Hitachi G model machines. It offers protection to the steel surfaces of the vessel. This inhibitor offers no noticeable protection for the copper or cupronickel tubes in the machine.

If an air leak develops, undesirables such as ammonia and NOx gas are generated. Nitrate inhibitor also has a high pitting corrosion potential due to an unstable magnetite film.

Nitrate inhibitor consumes hydrogen (byproduct of corrosion) and can hide the fact that a small leak(s) is present on the unit. If these small leaks exist for extended periods, they can lead to long-term corrosion problems. It is critical that small leaks are found and repaired in a timely fashion.

Lithium Molybdate (Li_2MoO_4)
Lithium molybdate inhibited solution actually comes from the manufacturer with a small amount of lithium nitrate added. This inhibitor offers no noticeable protection for the copper or cupro-nickel tubes in the machine.

During the first 20 or so hours of operation, the nitrate in solution helps to promote the formation of a very rough layer of magnetite as well as consume hydrogen in a chemical reaction. Between 20 and 200 hours, the molybdate works to refine this layer. The molybdenum actually becomes part of the film at higher temperatures offering increased protection.

The non-condensable production should be at an absolute minimum after 200 hours of operation, provided no air leaks are present. If air leaks are present, this protective film will not fully form. The presence of hydrogen in the purge tank (once the nitrate depletes) is a sure sign this has occurred.

Hydrogen generation has been a nuisance with this inhibitor. Even the smallest of air leaks (those that can only be found using helium mass spectrometer leak detection) will cause the magnetite film to break down leading to excess amounts of hydrogen being generated.

The majority of YORK's competitors are presently using Molybdate only inhibitor.

Advaguard 750™
Advaguard 750™ is an outstanding inhibitor and does not have the hydrogen sensitivity issues that molybdate has. Both the general corrosion and hydrogen generation rates are 8 times lower than molybdate. This inhibitor consists of two components Advaguard 750 A and Advaguard 750B.

Non-Condensable Monitoring

If the unit is generating an excess amount of non-condensables (determined by monitoring the purge frequency (units equipped with Smart-purge™), leak/bubble rate or trending the purge tank pressure differences (ParaFlow units only) the following sequence of events must be taken. The flow chart in Figure 2 illustrates the trouble-shooting process.

1. Take a solution sample and send to the lab for analysis. On the sample data sheet, record what type of inhibitor is being used in the machine that you are testing.

2. Make inhibitor corrections as indicated on the test report.

NOTE

Molybdate inhibited chillers only - The analysis report will not indicate how much nitrate to add. The technician will have to bring the nitrate level back to 75 mg/L. Always bring both the nitrate and molybdate levels to the top of their ranges at the same time. Both inhibitors must be present for the magnetite film to form. Refer to Figure 1 below to determine how much Nitrate to add. If the nitrate level is above 75 mg/L, no action is needed.

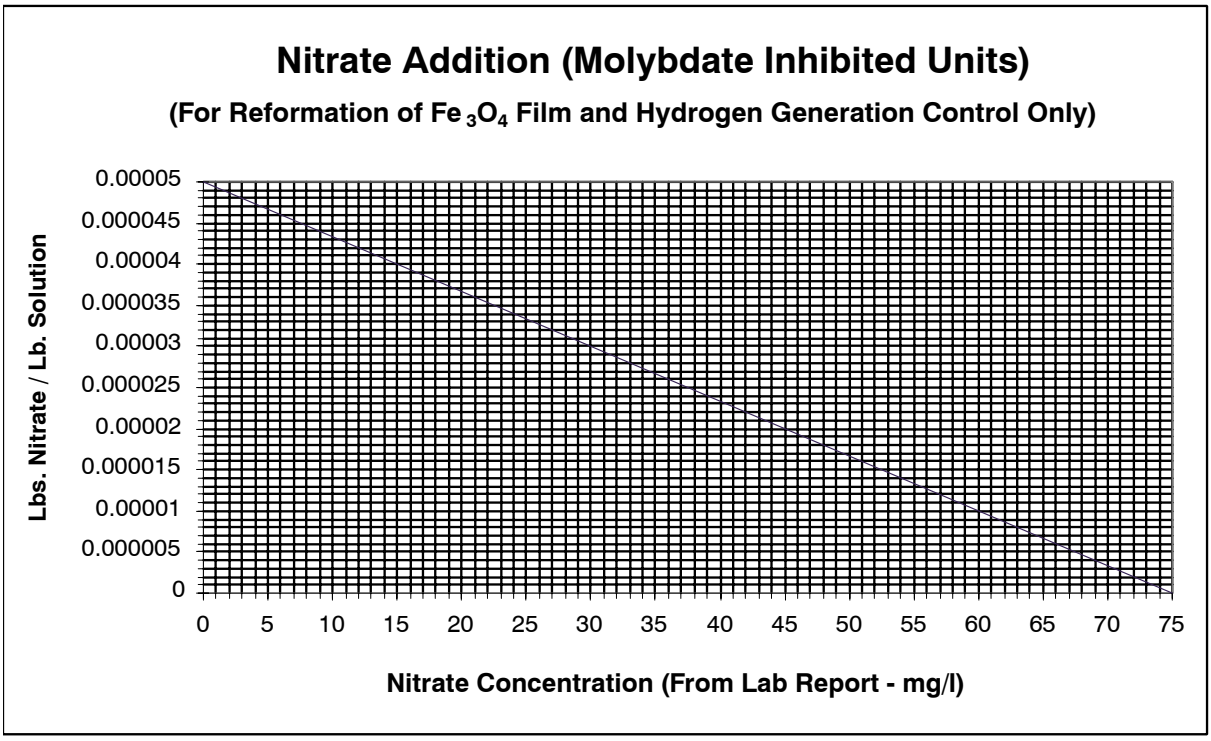

FIGURE 1 - NITRATE ADDITION TO MOLYBDATE INHIBITED UNITS

3. Monitor the non-condensable production. If the production drops to practically nothing and remains there, the problem was related to solution chemistry. If the non-condensable production drops and then gets worse again, an air leak is present. A leak test must be performed.

CAUTION

It is vital that all leaks are found and repaired as soon as possible to minimize internal damage to the machine.

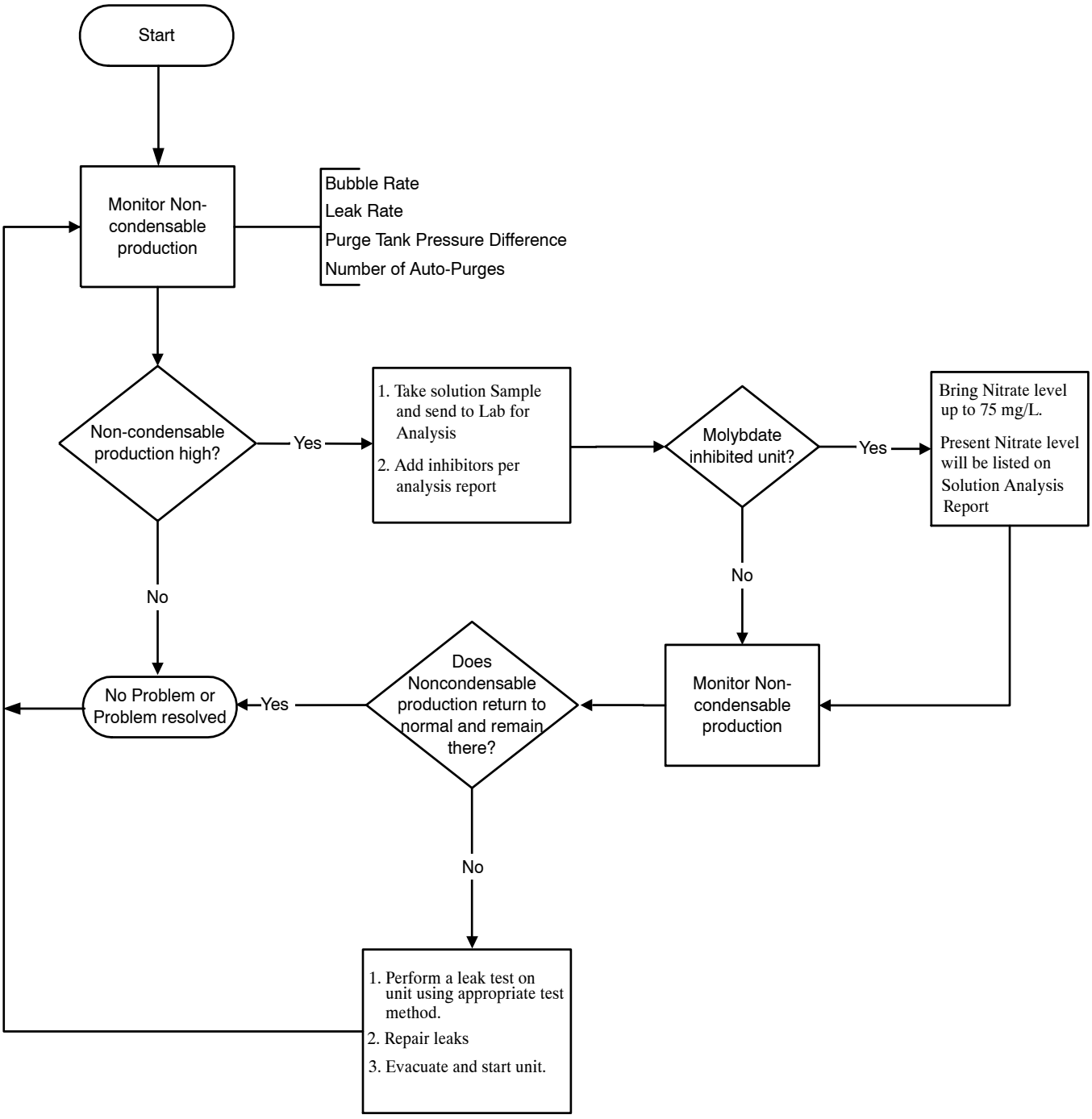

FIGURE 2 - TROUBLESHOOTING PROCESS