Corrective maintenance of ammonia leakage treatment at Sabroe Chiller Evaporator

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Abstract

This research deals with the problem of ammonia leakage from the Sabro-type chiller evaporator, where treatment is through corrective maintenance of the evaporator. This problem is considered one of the most serious problems in the food industries, where product cooling depends on the type of chiller .In this paper, we will study a chiller that uses ammonia gas with water, where there is a ammonia leakage in the cooling water line, resulting in mixing and saturation of the cooling water with ammonia gas performed is a corrective maintenance for the evaporator.

Keywords: maintenance-Chiller sabII, evaporator, ammonia leakage, treatment.

1- Introduction

A basic circuit of vapor compression refrigeration is in Figure 1(a). After compression, vapor is condensed with water cooling and then expanded to a low temperature through a valve in which the process is essentially at constant enthalpy. In large scale installations or when the objective is liquefaction of the ‘‘permanent’’ gases, expansion to lower temperatures is achieved in turbo-expanders from which power is recovered; such expansions are approximately isentropic. The process with expansion through a valve is represented on a pressure–enthalpy

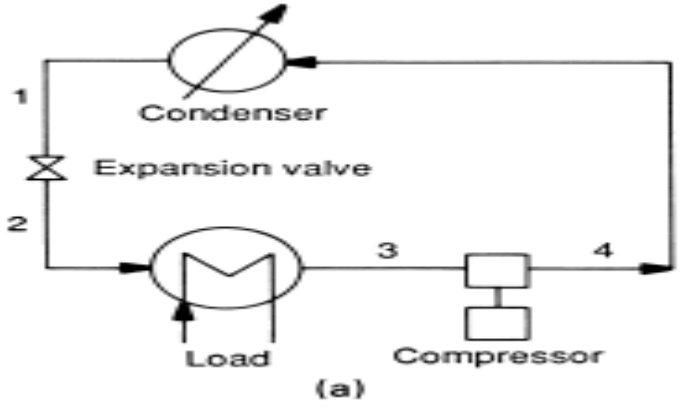

FIGURE 1(a)

The most widely used is ammonia absorption in water. Liquid ammonia at a high pressure is obtained overhead in a stripper, and then is expanded through a valve and becomes the low temperature vapor–liquid mixture that functions as the refrigerant. The low pressure vapor

Is absorbed in weak liquor from the bottom of the stripper. Energy input to the refrigeration system is primarily that of the steam to the stripper reboiler and a minor amount of power to the pump and the cooling water circulation.

This kind of system has a useful range down to the atmospheric boiling point of ammonia, -28F° or -33C°, or even lower. Two or three stage units are proposed for down to - 94F°. Sizing of

Equipment is treated by Bogart (1981).

Another kind of absorption refrigerant system employs aqueous lithium bromide as absorbent and circulating water as the refrigerant. It is used widely for air conditioning systems, in units

Of 600–700 tons producing water at 45F°.[1]

The type of compressor used generally has the greatest impact on the efficiency and reliability of a vapor-compression water chiller. The improvement of compressor designs and the development of new compressor technologies have led to more-efficient and -reliable water chillers. The reciprocating compressor was the workhorse of the small chiller market

For many years. It was typically available in capacities up to 100 tons [350 kW]. Multiple compressors were often installed in a single chiller to provide chiller capacities of up to 200 tons [700 kW]. Scroll compressors have emerged as a popular alternative to reciprocating compressors, and are generally available in hermetic configurations in capacities up to 15 tons [53 kW] for use in water chillers. As with reciprocating compressors, multiple scroll compressors are often used in a single chiller to meet larger capacities. In general, scroll compressors are 10 to 15 percent more efficient than reciprocating compressors and have proven to be very reliable, primarily because they have approximately 60 percent fewer moving parts than reciprocating compressors. Reciprocating and scroll compressors are typically used in smaller water chillers, those less than 200 tons [700 kW].

Air-Cooled or Water-Cooled condensing the heat exchangers in the water chiller (the condenser and evaporator) have the second greatest impact on chiller efficiency and cost. One of the most distinctive differences in chiller heat exchangers continues to be the type of condenser selected—air-cooled versus water-cooled. [2]

2- *PROBLEM DESCRIPTION*

1- Mixing between cooling water and refrigerant liquid (Ammonia).

2- Ammonia smell could be realized everywhere around coming from utility area.

3- Water and Ammonia mixture have corrosive effect for water fitting cycle.

4- Because of Ammonia – water mixture , one brass valve exploded leads to no person area cleaner and injured eyes.

5- The use of the chemical **phenol naphthalene** to detect the leakage of ammonia gas in the evaporator

3- *REPAIRING PROCEDURE*

1- Released the residual Ammonia from the ammonia cycle using nitrogen.

2- Cutting the sab II evaporator from its place at sab II chiller by using the angle grinder.

3- Removed the defected evaporator from its platform by using a forklift after all connections had been disconnected.

4- Disconnect all sensors wires which belong to evaporator.

5- Transfer the defected evaporator to the welding work shop for fixing.

6- While the part at work shop the cutting operation takes place as part of the maintenance action.

7- The pressure case was cut to detect the ammonia leakage point.

8- After the case had been cut, the evaporator exchange area was free for pressure testing.

9- A modification was place for exchanger pressure test.

FIGURE No (2) - The destructive evaporator

10- A forklift used to lifting the exchanger to the testing platform.

FIGURE No (3) - Reinstalling the evaporator in its pressure case

FIGURE No (4) - Isolate the evaporator area against the cutting

FIGURE No (5) - Remove the modification (treaded bar – nut)

4- INSPECTION RESULTS:

1- Pressure test leads to defected part of internal exchanger.

2- A small parts of metal was found inside the evaporator area.

It could be reason of the problem.

3- Full detection of the evaporator.

5- THE FOLLOWED REPAIRING PROCEDURE:

1- Removed the defected part of exchanger area.

2- Reconnect the exchanger then testing it under 20 bar pressure (for 2days) to detect any probable leakage.

FIGURE No (6) - Pressure test 20 bar

3- The evaporator placed on its case.

FIGURE No (7)- Placing exchanger its case

4- Covered the exchanger with its jacket.

FIGURE No (8)- Recovering exchanger with its jacke

5- The Blue dye has been used for leakage test later.

6- Tested under 16 bar (for 48 hrs.) as running pressure test while it is running on suction pressure 4 bar.

FIGURE No (9) - Pressure test 16 bar

7- The case filled with water during outside welding to protect the exchanger rubber jacket from welding heat.

8- Strength the welding area by using two flat metal bars.

FIGURE No (10) - Assembly the evaporator inside its case

9- Repaint the outside area with anti-rust primary.

FIGURE No (11) - Repainting evaporator case

10- Washing the inside surface with water and soap by circulation pump.

11- The humidity has been removed.

12- Transfer the repaired evaporator to its original place by forklift.

13- Reconnected the evaporator to the Ammonia cycle welding used.

14- Reconnected the flanges to the water cycle.

15- Inject the isolation foam between the evaporator body and its isolation cove.

16- Welding operation:

1- TIG technique was used.
2- Electrode E7018 Basque has been used.

Welding Electrodes Description:

E7018 is an excellent carbon steel electrode with iron powder low hydrogen potassium coating. It is used on both AC and DC in all position. As the coating contains iron powder, it has highly efficient welding and can reduce welding layers.

Application:

Used to weld low carbon structure and low alloy steel structure.

Chemical Composition of Wire (%):

C	Mn	Si	S	P
≤0.12	≤0.16	≤0.75	≤0.035	≤0.040

3- Preheating done for welding area. (Anti shrinking and minimize the Heat Effected zone. HEZ)

Preheating in hard facing procedures is the proper application of heat to the work piece to achieve a number of things.

• Aid in accomplishing a proper cool down after welding.

• Rid the work piece of any entrapped hydrogen after welding.

• Prevent excessive hardness in work piece heat-affected-zone (HAZ).

• Avoid unwanted structures or hardness in the weld deposit.

4- Electrode heated up for 1.5 hrs. As part of humidity release.

According to welding recommendations.

Electrodes must be baked for 1 hour at 100-120°c before welding

5- Welding grove width was 1.5 cm with 45° degree grove.

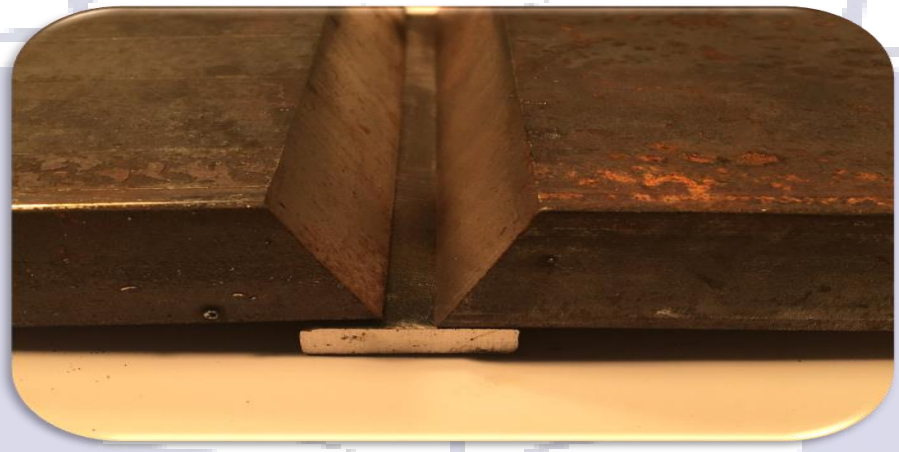

FIGURE No (12) - Plate grooving

FIGURE No (13) - Plate grooving

17- Re-Isolate the evaporator.

FIGURE No (14) - Re-isolate the evaporator body (cover supporting)

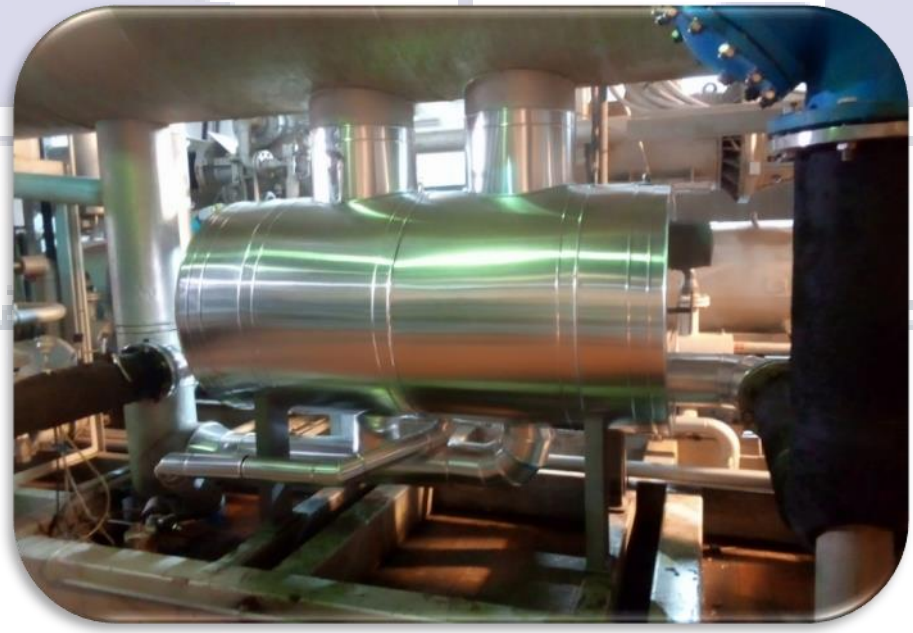

FIGURE No (15) - the evaporator body (cover supporting)

1- Fabricate a foam support placed under isolation cover.

2- PU FOAM (Cold Surface isolator) has been used as a glue.

3- Each support width was 6 cm according to another evaporator isolation, were the calibrator used to detect the isolation layer thickness.

4- The support will be rigid by tomorrow, so giving chance for foam to dry

6- Real running test.

Before real running test there some requirements have to be done.

1- Checking for cooling tower condition through checking fan motors,

V-belts, water make up valve, make up floater and circulation pump Circulation pump has been serviced, where its shaft seal has been replaced. [3]

2- Make sure of that, Evaporator water inlet and outlet valves is full opened.

3- Cooling tower is running AUTO MODE.

4- Chilled water circulation pumps are running.

5- From control screen choose MANUAL MODE.

6- MANUAL MODE is on YES option.

7- Then press one time arrow right.

8- Then press one-time arrow up.

9- Manual mode will be changed to NO.

MANOUL MODE = NO =< AUTO MODE.

The second timer will appear and counting then the compressor will start.

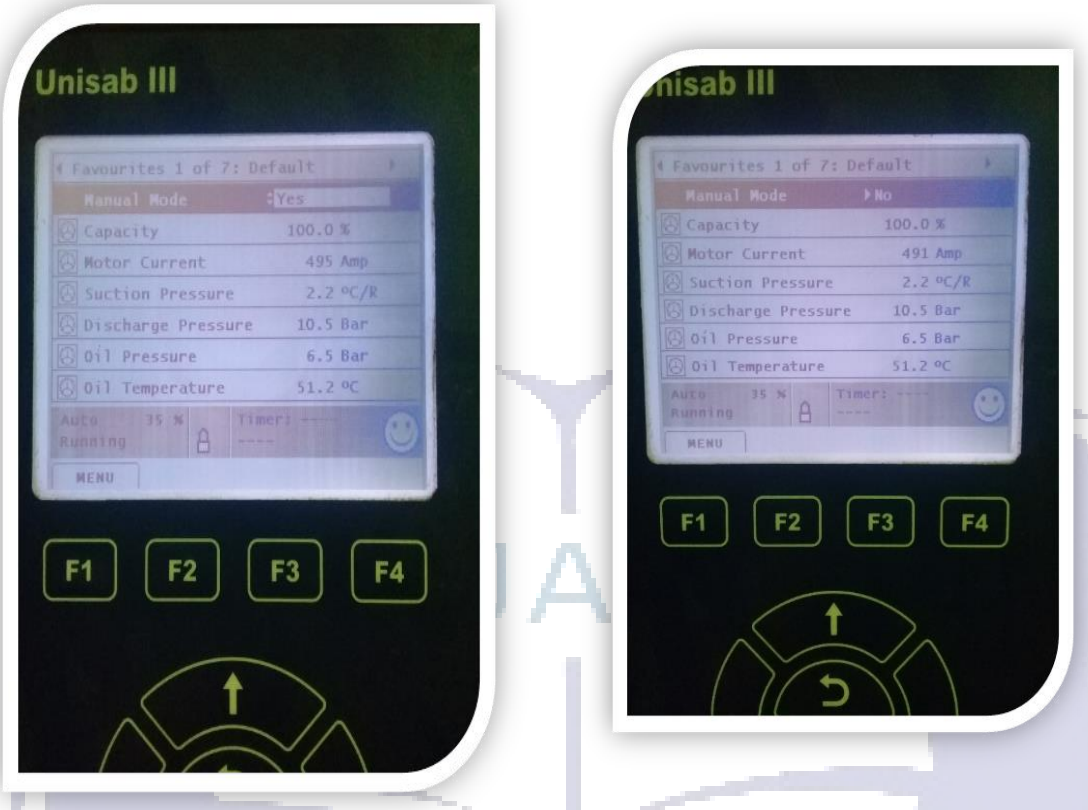

FIGURE No (16) - Real running test

7-Recommendations

In this paper, we recommend changing the manual valves in the water line entering the evaporator. Therefore, the maintenance engineer must inspect these valves and determine the period to change them.

It is necessary for the engineer operating this unit to determine the cooling temperature to avoid cooling the water more and not to reach the temperature of the water to the state of freezing, thus avoiding a crack or dent inside the evaporator.

We recommend checking the evaporator periodically and detecting any ammonia leakage through the use of naphthalene phenol. Where the white color turns to pink, this indicates the mixing of ammonia gas with water inside the evaporator.

Reference

1-chemical process equipment, selection, and design. Second edition. James R. Couper.

2- 2012 Trane All rights reserved TRG- TRCO 16-EN 24 Aug 2012.

3- Working group in the utility department of Judi Food Industries, the year 2021