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Modification of Evaporator used in VCRS and Its Reliability Measurement

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ABSTRACT

The aim is to improve the reliability of the evaporator by some technical modifications. Here it was observed that the reliability of evaporator is much more affected on the performance of evaporative coil. Hence to improve the reliability of evaporator, the concept of parallel redundancy is applied for evaporative coil. A system dynamic modeling of these modified systems projects a clear picture for the performance of evaporator for next fifteen years of its working[2].

Keywords: Reliability, Evaporator, Parallel Redundancy, System Dynamic Modeling.

I. INTRODUCTION

It was found that the reliability of evaporator is mainly affected by choking of the evaporative coil. Therefore in preliminary design of the evaporative coil some design considerations should be adopted to improve its features. On the basis of reliability theory, the concept of parallel redundancy can be used to improve the performance of evaporator for its long run [4].

The parallel redundancy concept cannot be applied for those components whose performances do not affect more on the reliability of system / subsystems/components. Here for leakage of refrigerant and for blockage of evaporative coil parallel redundancy concept of not necessary. Parallel redundancy for any component increases the initial cost of the system / subsystems/components therefore it can be used only for those components which largely affect the reliability of system/subsystems[1].

II. METHODS AND MATERIAL

A. System Dynamic Modeling of Modified Evaporator

Reliability of Evaporator [Modified] : ROE[M]
Leakage of Refrigerant[Modified] : LOR[M]
Choking in evaporative coil [Modified] : CIEC[M]
Blockage of Evaporative Coil [M] : BOEC[M]

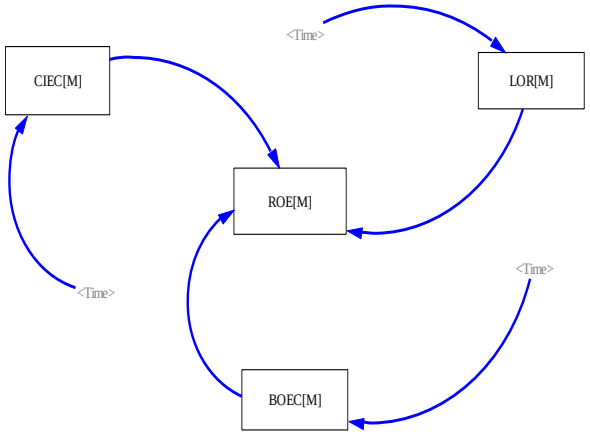

Figure 1 : System Dynamic Modeling of modified evaporator

A. Programing Details:

Basic Consideration: It is assumed that the reliability if all components are decreased exponentially and in case

of modification through parallel redundancy, the reliability of component also decreases exponentially.

(1) "BOEC[M]"= EXP(-0.003*Time)

Units: Reliability

(2) "CIEC[M]"= 1-(1-EXP(-0.011*Time))*(1-EXP(-0.011*Time))

Units: Reliability

(3) FINAL TIME = 15

Units: Year

The final time for the simulation

(4) INITIAL TIME = 0

Units: Year

The initial time for the simulation

(5) "LOR[M]" = EXP(-0.0034*Time)

Units: Reliability

(6) "ROE[M]"="BOEC[M]"*"CIEC[M]"*"LOR[M]"

Units: Reliability

(7) SAVEPER = TIME STEP

Units: Year [0,?]

The frequency with which output is stored

(8) TIME STEP = 1

Units: Year [0,?]

The time step for the simulation

B. Graphical Outputs

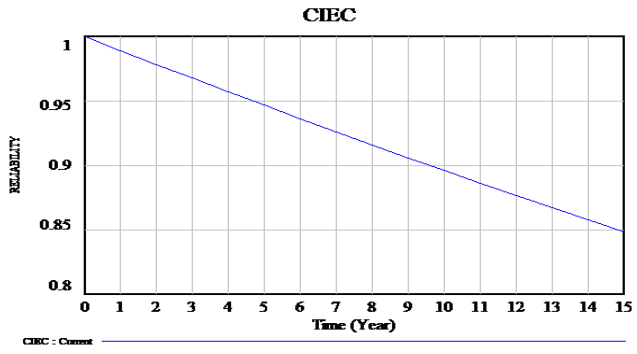

Figure 2: Reliability of evaporative coil regarding to its choking with time

Above graph shows that the reliability of evaporative coil regarding to its choking defect is decreasing with time. As time increase the chances of the choking of evaporative coils increase with time. The problems arise due to the depositing of dirt or scaling on inner circumference of evaporative coil. It becomes nearly 85% at the end of fifteenth year.

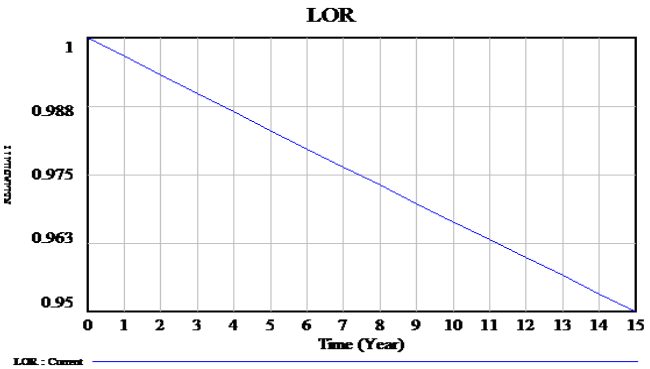

Figure 3 : Reliability variation of evaporator regarding to its leakage of refrigerant with time

Above graph shows that the material strength of various pipes and hoses decreases with time . This happens due to degradation by rusting or corrosion. This results that pipes of hoses may crack at different places and from these places, refrigerant leaks out and therefore defect arise due to the leakage of refrigerant.

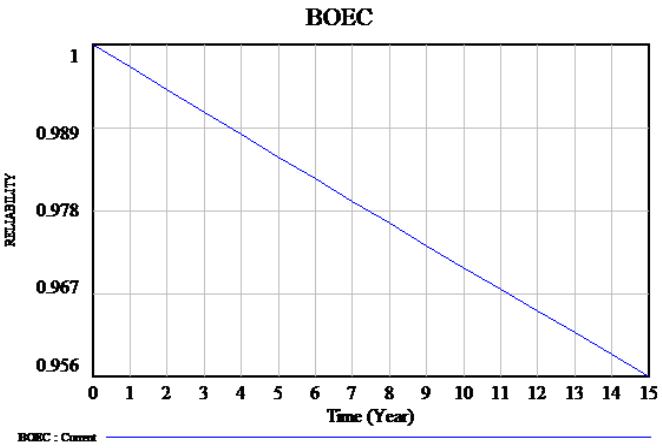

Figure 4 : Reliability of evaporator regarding to blockage in evaporative coil with time.

In vapor compression refrigeration system (VCRS) the reliability of evaporator decreases with time regarding to the blockage in evaporative coil . The reliability of evaporator becomes only 95% at the end of fifteenth year.

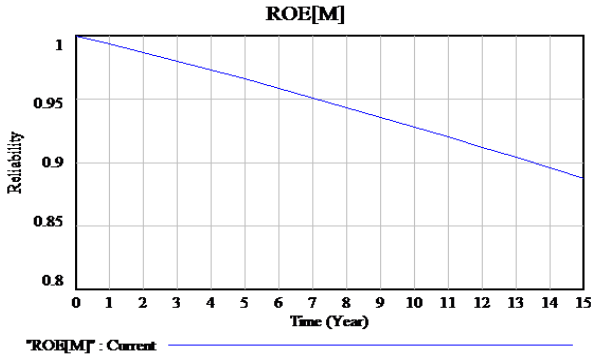

Figure 5: Graph showing reliability of overall evaporator including all components with time

This graph shows the overall reliability of evaporator if all possible defects are considered simultaneously.

C. Observation Table

Table 1: Variation of reliability of various components and evaporator with time

Time (Year)	"CIEC[M]" Runs:	"LOR[M]" Runs	"BOEC[M]" Runs	"ROE[M]" Runs:
0	Current 1	Current 1	Current 1	Current 1
1	0.99988	0.996606	0.997005	0.993501
2	*0.999527*	*0.993223*	*0.994018*	*0.986814*
3	0.998946	0.989852	0.99104	0.979949
4	0.998147	0.986492	0.988072	0.972919
5	0.997136	0.983144	0.985112	0.965733
6	0.995921	0.979807	0.982161	0.958402
7	0.994508	0.976481	0.979219	0.950937
8	0.992904	0.973167	0.976286	0.943347
9	0.991116	0.969863	0.973361	0.93564
10	0.989149	0.966572	0.970446	0.927827
11	0.987012	0.963291	0.967539	0.919916
12	0.984708	0.960021	0.96464	0.911914
13	0.982246	0.956763	0.961751	0.90383
14	0.979629	0.953515	0.95887	0.895671
15	0.976864	0.950279	0.955997	0.887446

III. RESULTS AND DISCUSSION

In modeling of the modified evaporator the concept of parallel redundancy is used to modify it. In practically observed failure data's for evaporator for last fifteen years, it was seen that the reliability regarding to leakage of refrigerant [LOR], blockage of evaporative coil [BOEC] are not affecting much more in the performance of evaporator. This is the reason that parallel redundancy is not necessary for these factors. This concept is applied only for choking in evaporative coil [CIEC]. Now the reliability of evaporator regarding to blockage of evaporative coil increases from 84.78% to 97.68%. Therefore overall reliability of evaporator is enhanced for next fifteen years.

IV. CONCLUSION

It is clear from the observation table and the output observed from graph the reliability of evaporator increases considerably from 77.02 % to 88.74% at the end of fifteenth years. This higher reliability percentage is fairly acceptable for long run application of the system [3]. No doubt this value of reliability for evaporator increases the overall reliability of the vapour compression refrigeration system (VCRS).

V. REFERENCES

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