



RISK ASSESSMENT OF DECREASING THE FAILURE OF THERMAL LIQUID COLLECTOR

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Abstract:

Object of the study is an evaluation of applied remedies at a process of decrement of failure of the thermal liquid collector by application of FMEA method. Remedies that lead into the minimisation of failures are proposed after identification and evaluation of potentially failures.

Key words: risk assessment, collector, failure

INTRODUCTION

Manufacturing process is a part of the management systems that involves determination of an optimal, the most economical or productive conditions of realized manufacturing process operation. Management system has to assign that a manufacturing process satisfies its defined usage without any undesirable failures or risks [3, 5, 6].

A solar water heating is the oldest way of usage of the solar energy. Devices that are used for this purpose are called thermal collectors. Collectors absorb the solar radiation and change it into heat. This heat is stored in water or air and it is used for a preparation of the hot water in buildings. It also can be used for heating pools, for cooking or drying agricultural farming products. Thermal collectors can be used practically in all situations of warming.

Preparation of hot water is the second highest item (after heating) which is paid by average family as energy consumed in a household. Sometimes it is the highest item for them. Water heating by the thermal collectors can decrease costs for heat noticeably, even of 70%. Solar collector which can be used also for water pre-heating is a simple device without almost any maintenance.

MATERIAL AND METHODS

Flat collector is considered to be the most used type of a collector. Solar radiation passes over a cover and fall on an absorption body where it is changed into heat. The absorption body is a conductive disk with a suitable absorption layer. Heated water flows in pipes that are connected well with the absorption body. The most common heated liquid is water with an antifreeze or oil. Construction, adaptation of a surface and material selection are determined so that it would be the most efficient collector with appropriate costs. The flat liquid collector (Fig. 1), consists of the cover (protecting layer), frame, absorption body (absorption layer), isolation and mains.

Several methods which are applied mostly in areas where a human failure of the system "human-machine-

environment" causes an extensive damage are introducing for the risk evaluation. Those methods are f. e. FMEA (Failure Mode and Effects Analysis) that is applied in technical systems for a purpose of identification, resp. decrement of probability of a negative occurrence linked with failure of the technical system [7, 8].



Fig. 1 Flat thermal liquid collector of typical categorization TS 300

Process of application:

- Definition of the system and determination of its functional and minimal operating requirements.
- Formulation of functional and reliability's block diagrams, mathematical models and captions.
- Determination of the basic principles and relevant documentation that are needed for an analysis.
- Definition of potential failures.
- Formulation of all effects of the failures.
- Seeking and detecting causes of the failures.
- Definition of an importance, occurrence of discovered failures.
- Calculation of the risk/priority RPN (product of importance, occurrence and uncovering).
- Definition of an order of failures according to RPN.
- Promotion of remedies.
- Application of remedies.
- Risk evaluation after the applied remedies by determination of importance, occurrence, uncovering of failures and calculation of the risk degree.

Table 1
Applied method FMEA in the process of failure decrement of liquid thermal collector

Potential failures	Failure effects	Failure causes	Importance	Occurrence	Uncovering	RPN	
Damaged bath of a collector	Liquid leakage	Weather conditions	7	1	3	21	
Damaged crystal board	Crack	Hailstorm	5	5	1	25	
		Vandalism	5	2	1	10	
Damaged absorption body	Lustreless of a surface	Dusty environment	5	2	1	10	
		Lack of a solar energy	Vandalism	7	1	1	7
Damaged mains	Liquid leakage	Defect of gasket	7	3	1	21	
		Low quality of a joint	7	1	1	7	
		Corrosion	7	2	1	14	
		Strange object	7	5	2	70	
Damaged exchanger	Drop pressure	Seizing of a encircling pump	9	1	2	18	
		Insufficient change of energy	Aerating of a encircling pump	3	2	3	18
			Dirty encircling pump	4	4	4	64

Table 2
Method FMEA after applied remedies

Potential failures	Failure effects	Failurecauses	Importance	Occurrence	RPN	
Damaged bath of a collector	Regular control		7	1	1	7
			5	2	1	10
Damaged crystal board	Board protection		5	1	1	5
			5	1	1	5
Damaged absorption body	Board protection		7	1	1	7
			7	1	1	7
			7	1	1	7
Damaged mains	Cover of mains		7	1	1	7
			7	1	1	7
			7	2	2	28
Damaged exchanger	Regular control Regular service		9	1	1	9
			3	1	2	6
			4	2	2	16

RESULTS AND DISCUSSION

Potential failures with causes and effects at the process of the failure decrement of the liquid thermal collector are depicted in Table 1. Applied methods FMEA and RPN before the remedies are also stated.

Both remedies that were applied in the manufacturing process and the qualitative output of method FMEA are defined in Table 2.

CONCLUSIONS

Risk management is the process with a centre of which is determination of the real risks at operation and its minimizing or its removing. Recourse of the risk management is its examination with aim to identify all actual and potential negative factors of a work by systematic inspection. It is expressed as a combination of a frequency or a probability of occurrence of specified dangerous accident and expected effects of that accident [1, 2, 4].

Application of the method FMEA in the process of fail-

ure decrement of the liquid thermal collector leads us to the statement that the most risky potential failure was the damage of system mains that was caused by strange object. Remedies that led to noticeable minimization of the risk rate and to minimization of the failure probability were proposed.

The method helped to uncover the potential failures, decreased the probability of their occurrence and therefore we could state that it satisfied its objective.

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