Bulletin of the *Transilvania* University of Braşov
CIBv 2015 • Vol. 8 (57) Special Issue No. 1 - 2015

FUNCTIONS DETERMINING ON ABSORPTION REFRIGERATION SYSTEMS (IFA) WITH VALUE ENGINEERING ANALYSIS METHOD (AIV)

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Abstract: *Because in the analysis and value engineering (AIV), a product is considered as a sum of functions and not components, this is true also for absorption refrigeration system (IFA) within air-conditioning installation. It is very important to set correctly all these functions because the omission or incorrect classification of some of them, would lead to inaccurate assessments. The role of refrigeration systems should not be confused with their functions because the expression is general and encompasses many distinct functions, functions that must satisfy the requirements of users.*

Key words: *functions, refrigeration, systems, value engineering.*

1. Introduction

Using these systems enables the possibilities in continuity of air cooling process in the warm periods of the year, depending on the performance of components and user requirements [1].

We consider that in absorption refrigeration systems (IFA), the functions can divided into the following categories:

- functions or functions use: are the function that define the use of refrigeration (absorption - for comfort air conditioning);
- functions of appreciation: are those functions that make choosing a particular element of the system (heat exchanger: multitubular, plates or micro channels etc.) or limitations of thermodynamic processes (depending on the characteristics of the refrigerant, equipments, pipes and accessories);
- execution functions (output of the device) are those functions that are required by the user through the requirements listed, but allows the person that construct the installation to "build" user and appreciation functions.

We believe that, in determining the functions, descriptions in general terms should be avoided, descriptions that would group two or more functions.

The role of refrigeration systems related to the air conditioning comfort is to reduce and maintain the temperature of an environment under ambient temperature by continuous evacuation of the heat to the environment [2].

User requirements in this case, we find in

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a series of acts of which the most important is the Law. 10/1995 - Law of construction quality, as amended by Law 177/2015.

In compliance with the requirements listed and established based on the requirements to the system, both system and components will have to fulfil a number of functions that will give them usage value.

In the following we will establish system absorption refrigeration functions (IFA) - functions - based on the quality requirements of the Law 10/1995 as amended by Law 177/2015 [3].

This normative act establishes a set of quality requirements to be met both the construction and integrated systems of installation - implicitly - their subassemblies.

Under this law - quote "Applying basic requirements is established on domains / sub domains and categories of construction and installation related to construction specialities."

Basic requirements (Law 10/1995), to obtain construction / installation quality are - compulsory - for the entire duration of the construction / installations and there are:

- mechanical resistance and stability;
- fire safety;
- hygiene, health and the environment;
- safety and accessibility in exploitation;
- protection against noise;
- energy saving and thermal insulation;
- the sustainable use of natural resources;

We wish to point that applying the AIV method to a refrigeration system in the context of function setup, taking into account the quality of construction / installation can be considered an original initiative [4].

2. Instructions for Editing Functions of an absorption refrigeration system (IFA) - based on the quality requirements of the Law 10/1995 as amended by Law 177/2015 Establishing the weight functions the usage value by using the process of ordering

IFA functions necessary to satisfy quality requirements „Mechanical resistance and stability" Table 1

No.	Name of quality	No.	Functions
1.	Mechanical resistance and stability	1.1	Provides resistance and mechanical actions
		1.2	Provides resistant to internal and external corrosive agents
		1.3	Presents functional reliability

IFA functions necessary to satisfy quality requirements „Fire safety" Table 2

No.	Name of quality	No.	Functions
2.	Fire safety	2.1	Presents resistance to fire
		2.2	Provides tightness

IFA functions necessary to satisfy quality requirements „Hygiene, health and the environment " Table 3

No.	Name of quality	No.	Functions
3.	Hygiene, health and the environment	3.1	Ensures constant chilled water temperature
		3.2	Provide low level of vibration

IFA functions necessary to satisfy quality requirements „Safety and accessibility in exploitation " Table 4

No.	Name of quality	No.	Functions
4.	Safety and accessibility in exploitation	4.1	Ensure the transmission of heat flow from the agent to the environment
		4.2	Allows movement

			working fluids safely
		4.3	Ensures technology reliability

IFA functions necessary to satisfy quality requirements "Protection against noise"
Table 5

No.	Name of quality	No.	Functions
5.	Protection against noise	5.1	Provides acoustic protection / quiet operation

IFA functions necessary to satisfy quality requirements " Energy saving and thermal insulation"
Table 6

No.	Name of quality	No.	Functions
6.	Energy saving and thermal insulation	6.1	Provides energy economy

IFA functions necessary to satisfy quality requirements "Sustainable use of natural resources "
Table 7

No.	Name of quality	No.	Functions
7.	Sustainable use of natural resources	7.1	It allows reducing energy consumption from conventional resources

In addition to these functions and function assessment identified: "It has aesthetic"

According to STAS 11272-79 - "Standard functions consist of all functions about object studied in terms of satisfying social needs". The standard is to present in an order, refereed chosen, at this stage all the functions of their type and units of measurement, Table 8:

Functions standard, proposed for IFA
Table 8

No	Function	Name of function	Type of function	Units	Obs.
1	**F1**	**Provides resistance and mechanical actions**	**Main Objective**	*daN/cm²*	FPO*
2	F2	Provides resistant to internal and external corrosive agents	Main Subjective	*years*	**FPS****
3	**F3**	**Presents functional reliability**	**Main Objective**	*years*	FPO
4	F4	Presents resistance to fire	Main Subjective	*minutes*	**FPS**
5	F5	Provides tightness	Main Subjective	cm^3/min	$(FA)_{F9}$
6	**F6**	**Ensures constant chilled water temperature**	**Main Objective**	$t^0 C$	FPO
7	**F7**	**Provide low level of vibration**	**Main Objective**	*Hz*	FPO
8	F8	Ensure the transmission of heat flow from the agent to the environment	Main Subjective	W/m^2	**FPS**
9	**F**9	**Allows movement working fluids safely**	**Main Objective**	*bar;$t^0 C$; l/s;%*	FPO
10	**F1**0	**Ensures technology reliability**	**Main Objective**	*years*	FPO

11	F11	Provides acoustic protection / quiet operation	Main Subjective	dB	FPO
12	**F12**	**It allows reducing energy consumption from conventional resources**	**Main Objective**	*kW*	FPO
13	**F13**	**It is aesthetic**	**Main Objective**	**form, color**	**FPS**

FPO * = Main objective function

FPS * = Main subjective function

We will consider only the main functions F1 ÷ F13, except for F5 which is an auxiliary function.

3. Establishing the Share of Functions in the Usage Value by Using the Direct Ordering Process

To determine the importance of the use-value functions we applied the direct ordering process.

This process consists in:

- Making a survey conducted on a sample of users (in this case have interviewed 13 people). The sample (using the procedure) need to be randomized, representative and to contain the user from various groups. To interview selected sample was drawn a form survey sheet, which includes absorption refrigeration system functions.

Given the complexity of the product they have proposed three categories used to assess the technical functions of the assembly:

a. Engineers and technicians, specialists from some specialized companies - who assembles and provides service of such equipment;

b. Professors whose teaching and research activity includes the artificial cold;

c. Any users / beneficiaries of such a refrigeration system (which currently use - for home or office air conditioner - including car air-conditioning systems with mechanical vapour compression)

- Sheet survey was mainly intended to complement matrix interactions, but - at the same time - asked a few questions and answers relevant and enlightening conclusions in this case (questions are interspersed at the end of the survey sheet).

Results from the survey sheets for the 13 interviewees, have created a range of values for each function values that have been reported in Table 9 as follows:

After the survey, to determine IFA share functions for the use value, the following results were obtained (Table 10):

The share of each function in the use value is determined using the relationship:

$$p_j = \frac{N_j}{\sum_{j=1}^{13} N_j} \qquad (1)$$

Referring to the results and comments made by users, we conclude that our proposed list can be considered correct.

4. Conclusions

Relevant to the preparation of the standard functions for the IFA most important conclusions are:

- Most users consider the function F6 - "Ensures constant chilled water temperature" - is the most important (it is natural, because it expresses, in fact even "functioning core" of refrigeration system);

- The lowest score was obtained F4 function - "fire resistant". We think it is - somehow - justified this score because sub-assemblies are protected by housing (which is made by materials resistant to

fire). However this function applied to other parts of the IFA (excluding housing) don't have use value to influence the " user comfort "

Sheet for registration of survey results Table 9

No	Function	Name of function	Appreciations				Amount marks
			S_1	S_2	... ...	S_k	
1	F1	Provides resistance and mechanical actions	$a_{1,1}$	$a_{1,2}$	... ...	$a_{1,k}$	$N_1 = \sum_{i=1}^{k} a_{1,i}$
2	F2	Provides resistant to internal and external corrosive agents	$a_{2,1}$	$a_{2,2}$	... ...	$a_{2,k}$	$N_2 = \sum_{i=1}^{k} a_{2,i}$
3	F3	Presents functional reliability	$a_{3,1}$	$a_{3,2}$	... ...	$a_{3,k}$	$N_3 = \sum_{i=1}^{k} a_{3,i}$
4	F4	Presents resistance to fire	$a_{4,1}$	$a_{4,2}$	... ...	$a_{4,k}$	$N_4 = \sum_{i=1}^{k} a_{4,i}$
5	F5	Provides tightness	$a_{5,1}$	$a_{5,2}$	... ...	$a_{5,k}$	$N_5 = \sum_{i=1}^{k} a_{5,i}$
6	F6	Ensures constant chilled water temperature	$a_{6,1}$	$a_{6,2}$	... ...	$a_{6,k}$	$N_6 = \sum_{i=1}^{k} a_{6,i}$
7	F7	Provide low level of vibration	$a_{7,1}$	$a_{7,2}$	... ...	$a_{7,k}$	$N_7 = \sum_{i=1}^{k} a_{7i}$
8	F8	Ensure the transmission of heat flow from the agent to the environment	$a_{8,1}$	$a_{8,2}$	... ...	$a_{8,k}$	$N_8 = \sum_{i=1}^{k} a_{8,i}$
9	F9	Allows movement working fluids safely	$a_{9,1}$	$a_{9,2}$	... ...	$a_{9,k}$	$N_9 = \sum_{i=1}^{k} a_{9,i}$
10	F10	Ensures technology reliability	$a_{10,1}$	$a_{10,2}$	... ...	$a_{10,k}$	$N_{10} = \sum_{i=1}^{k} a_{10,i}$
11	F11	Provides acoustic protection / quiet operation	$a_{11,1}$	$a_{11,2}$	... ...	$a_{11,k}$	$N_{11} = \sum_{i=1}^{k} a_{11,i}$
12	F12	It allows reducing energy consumption from conventional resources	$a_{12,1}$	$a_{12,2}$	... ...	$a_{12,k}$	$N_{12} = \sum_{i=1}^{k} a_{12,i}$
13	F13	It is aesthetic	$a_{13,1}$	$a_{13,2}$	... ...	$a_{13,k}$	$N_{13} = \sum_{i=1}^{k} a_{13,i}$
							$N = \sum_{j=1}^{13} N_j$

Results of poll on the importance of functions-value (share value functions) – IFA

Table 10

No	Function	Appreciations												Amount marks
		S1	S2	S3	S4	S6	S7	S8	S9	S10	S11	S12	S13	
1	F1	5	6	7	5	6	3	7	5	4	4	6	5	63
2	F2	4	3	6	2	3	4	2	3	5	5	1	1	39
3	F3	10	11	10	11	10	11	12	11	11	12	11	12	132
4	F4	3	1	3	3	4	5	3	4	2	2	4	4	38
5	F6	12	10	12	12	11	12	10	12	12	10	12	11	136
6	F7	6	5	4	6	5	6	6	7	6	7	5	7	70
7	F8	2	4	2	1	2	2	1	2	1	1	2	2	22
8	F9	7	8	5	7	7	7	5	6	7	6	8	6	79
9	F10	11	12	11	10	12	10	11	10	10	11	10	10	128
10	F11	8	7	8	9	8	8	9	9	8	8	7	8	97
11	F12	9	9	9	8	9	9	8	8	9	9	9	9	105
12	F13	1	2	1	4	1	1	4	1	3	3	3	3	27
		78	78	78	78	78	78	78	78	78	78	78	78	936

- It was also suggested the introduction of new functions:

a. use an organic agent (possibly ammonia - NH3);

b. allow control and viewing operational status (as that integrates housing subassemblies allows direct access to the components);

c. be able to ensure a better maintainability.

Although setting the level of importance of the functions of a ensemble apparently poses no particular problem, this operation is of great importance for the success of AIV approach because it requires thorough knowledge of the product, its operating conditions and social requirements.

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