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The influence of electromagnetic interference of electrical work in fire

Streszczenie. *Na poprawność działania urządzeń wpływa wiele czynników takich jak: wahania częstotliwości, impulsy napięciowe i przepięcia, spadki napięć, zaniki zasilania, czy zmiana rezystancji kabli zasilających. Jakość dostarczanej energii elektrycznej do silników klap dymowych, wind pożarowych czy też pomp wodnych ma duży wpływ na poprawność działania tych urządzeń, a tym samym na sprawność przeprowadzania ewakuacji. Przeprowadzone badania mają na celu skonfrontowanie wpływu zakłóceń elektromagnetycznych wynikających z jakości dostarczonej energii elektrycznej na moment silnika 3 fazowego prądu przemiennego dla wybranych warunków obciążenia. Badania zostaną przeprowadzone w laboratorium Centralnej Szkoły Państwowej Straży Pożarnej w Częstochowie.*

Abstract. *For the operation of the device is affected by many factors such as: frequency swing, impulse voltages and spikes, voltage drops, power failures or resistance changes in the lead wires. The quality of energy supply has great impact on the performance of smoke damper motors, fire lifts or water pumps, thereby influencing the evacuation efficiency. The aim of the research is to study the effect of electromagnetic interference associated with energy supply quality on the moment of inertia of a three-phase motor under selected loading conditions. The research will be conducted in the laboratory in The Central School of the State Fire Service in Czestochowa.* ***(Wpływ zakłóceń elektromagnetycznych na pracę urządzeń elektrycznych w warunkach pożaru)***

Słowa kluczowe: urządzenia elektryczne, zakłócenia elektromagnetyczne, warunki pożarowe, silnik indukcyjny.
Keywords: electrical equipment, electromagnetic interference, fire conditions, induction motor .

Introduction

Fire safety puts a lot of emphasis on the human factor. Therefore proper needs are to be met as for buildings and electrical power devices fitted inside them as well as the power installation itself, which is reflected in Directive 92/31/EEC, 93/68/EEC and 98/13/EC that enable, after fulfilling them, to lower the risk of threats. The latest literature recognizes that as electromagnetic disturbances it should be understood each and every electromagnetic phenomenon that can worsen the work of a device or a system. A disturbance can be the signal coming from another system used in the same environment, electromagnetic noise, unwanted signal caused by natural phenomena, e.g. lightning or electromagnetic discharge, change of propagation properties of the environment, short nonstationary state in electric circuits, etc., [2]. Necessary factors to create fire, so called triangle of combustion, can be also responsible for electromagnetic disturbances.

Influence of voltage drop on efficiency of induction motors working in fire conditions

Every device, e.g. pumps in fire emergency pumping stations, fire-resisting dampers, smoke ventilation devices, explosion protecting devices, fire doors and gates, provided they are equipped with controlling systems, [6] requires constant power while working. It is needed to supply a continuity of electric energy supply during specific time into powered devices taking part in extinguishing fire. Unfortunately, occurring interferences and also electromagnetic disturbances, caused by many factors that have influence on decays and quality of supplied energy, directly affect on proper work of these devices, table 1, [3]. Moreover, the high temperature present in fires has much influence on cables in the vicinity, which may lead to resistance increase several times.

For the needs of this analysis tests and studies were carried out on the work of 3 phase induction motor in emergency conditions, constantly forcing voltage drops and recording their impact on turning moment and at the same time on water pump efficiency and systems of ventilation. The above tests were conducted on laboratory stand, fig.1, in Central School of the State Fire Service in Czestochowa.

Table 1. The percentage changes of values of engine parameters for selected voltage deviation.

Size	Changes in the value of the deviation of the value of the voltage	
	-10%	+10%
motor torque	-19%	+21%
speed	-1,5%	+1%
efficiency	-2%	+(0,5-1)%
power factor	+0,01%	-0,03%
stator current	+11%	-7%
stator winding temperature rise	+(6-7)%	-(3-4)%

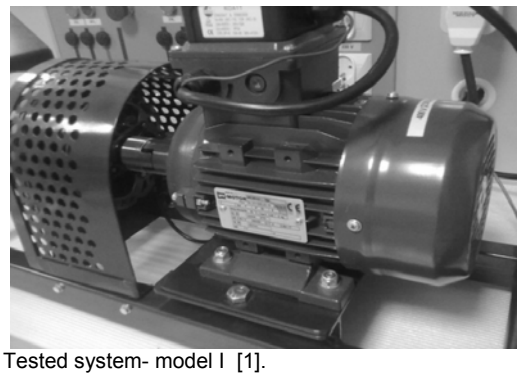

Fig. 1 Tested system- model I [1].

In this research laser devices for measuring rotational speed for demanded values were used. Voltage drop was held at the level of 0.9 Un, at steady load conditions. Decline of voltage stimulated the negative influence of fire environment on feeder cables. There was an observation recorded of some electrical parameters which were the answer to external disturbances. One of these parameters was a coefficient of harmonic contents in feeding voltage of tested circuit, fig.2 and fig.3.

It should be mentioned that due to some stands' restrictions involving among the others internal protection of induction motor against overheating, the studies were brought only to the certain phase of environmental conditions imitating fire, namely glowing combustion. The temperature present in fire causes reduction of electrical conductivity of wires resulting in interferences in quality of supplied electric energy, manifesting itself by excessive voltage drop and thereby worsening the conditions of fire protection of devices.

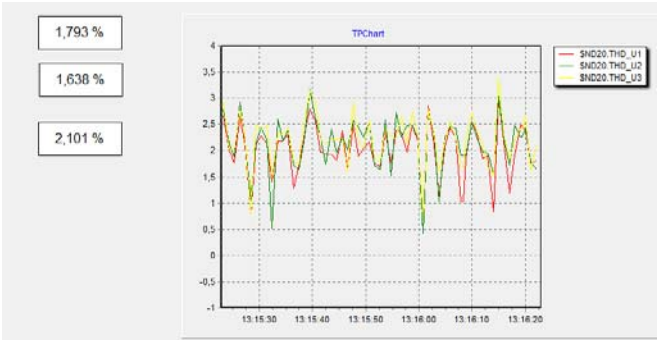

Fig.2 Layout of coefficient of harmonic contents in feeding voltage with percentage value averaged in phase L1,L2, L3 in 40 minutes of working of external factor, [author's study]

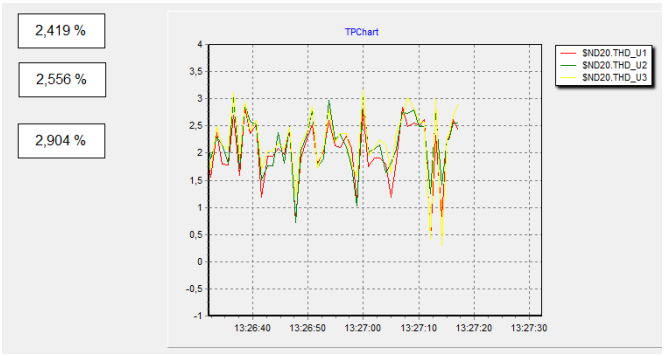

Fig. 3 Layout of coefficient of harmonic contents in feeding voltage with percentage value averaged in phase L1,L2, L3 in 50 minutes of working of external factor

The studies were carried out on a motor set connected with controlled load. The first way of testing involved changes of voltage values within the frames 230-200V with the work of motor at idle running. Measurement results were very similar to each other with a minimal difference, and voltage drops exceeding 10% have not any impact on the work of motor at the idle running.

Measurement data, which were obtained at the work of this power transmission system – fig.1. for two voltage values 230V and 200V but for two various electronic loads within 400W – 1400W bracket, show that with the increase of electronic loads, the declines of rotational speed could be observed as from 2903 rpm and 400W to 2713 rpm for 1400W, table 2. For a comparison the studies were carried out on the assumption that during a fire some external factors, which caused voltage drop to value of 200V, worked. From obtained data it is easy to see that the changes of electronic load have a significant influence on the turning moment.

Table 2. Change of feeding parameters

Supply voltage 230V	Supply voltage 200V	Electronic load
2903 rpm	2853 rpm	400W
2835 rpm	2726 rpm	800W
2758 rpm	2576 rpm	1200W
2713 rpm	2500 rpm	1400W
2663 rpm	-	1600W

Assuming that such a power transmission system constitutes the power supply of fire pump, one can notice that the change of rotational speed in line with the dependence (1) has a directly proportional influence on capacity of such a pump, and consequently has a direct influence on the pump capacity in line with the dependence (2) [3]:

$$Q_2 = Q_1 \frac{n_2}{n_1} \quad (1)$$

$$H_2 = H_1 * \left(\frac{n_2}{n_1} \right)^2 \quad (2)$$

Final conclusions

Fire development depends on the source of fire initiation, composition and number of materials, orientation and geometry of room as well as localization and size of vents. Fire in a compartment includes the whole phenomena related to creation and spreading of combustion zone that is flames, creation of gas products from thermal decomposition – smoke and heat exchange in a compartment and in its immediate vicinity, [5].

Many factors of the surrounding environment in direct or indirect way influence the occurrence of electromagnetic disturbances that have negative impact on the performance of devices. Time constitutes a component connecting fire conditions and electromagnetic disturbances and over its course the evacuation conditions form the place of fire worsen.

Environmental conditioning having impact on electromagnetic disturbances influence the parameters that serve the quality assessment of electric energy and at the same time provide direct information about reliability of power supply.

Apart from unfavourable conditions that result from the performance of the fire, other factors should also be considered, that is voltage fluctuations, which are less noticeable, however they have a very negative influence on devices such as motors and cause their and machines driven by them faster wear and tear. Considering this wide spectrum of conditionings can as a result give complete assessment of the influence of electromagnetic disturbances on electrical devices operating in fire conditions. What is more, the knowledge of all conditionings that have negative influence on operation of devices will allow to design the supply system so as to avoid, at the higher degree possible, the worsening of quality of electric energy that supplies electromechanical systems.

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