- привлечение в группы качества значительно более широкого круга трудящихся и повышение их активности и эффективности работы;

- расширение и претворение в жизнь целого комплекса мероприятий, обеспечивающих реализацию человеческого фактора в производственных и социальных отношениях;

- использование профессионалов в области управления качеством продукции при проведении всех работ по совершенствованию системы управления качества продукции.

В целом внедрение в жизнь всех предложенных мероприятий, направленных на совершенствование системы управления качеством в ПАО «Омский шинный завод», позволит повысить внутреннюю и внешнюю надежность предприятия; уменьшить число рекламаций; упорядочить и уменьшить количество документов; повысить конкурентоспособность, улучшить качество выпускаемой продукции.

Таким образом, выше перечисленные мероприятия позволят совершенствовать систему менеджмента качества ПАО «Омский шинный завод», что в свою очередь позволит предприятию повысить качество выпускаемой продукции и взаимовыгодное сотрудничество с поставщиками и потребителями.

Литература

1. Крейг, Р. Взаимосвязь между МС ИСО серии 9000 и американской национальной премией по качеству имени Малкольма Болдриджа // Методы менеджмента качества. 2008. - №7.

2. Основы управления качеством: Учеб. пособие / Под ред. С.К. Фомичева, А.А. Старостиной, Н.И. Скрябиной. – 4-е изд. – К.: МАУП, 2012. – 192 с.

3. Пискунова, Н.Н. Анализ критических факторов от внедрения автоматизированных систем управления качеством // Менеджмент в Росси и за рубежом. – 2008. - №1. – С. 69 – 76.

4. Прокофьева, Н.П. Разработка и внедрение системы менеджмента качества // Стандарты и качество. 2010. - № 2. – С. 2 – 9.

Научный руководитель : к. т. н. доц. Норченко П.А.

Статья отправлена: 04.04.2017 г.

© Стебенькова А.О.

ЦИТ: ua117-100
DOI: 10.21893/2415-7538.2016-05-1-100
UDK 331.46:614.82

Сірик А.О., Євтушенко О.В., Єфіська Ю.Ю., Овчарова Д.А.

АНАЛІЗ ЕФЕКТИВНОСТІ ВИКОРИСТАННЯ МЕТОДУ «ДРЕВА ВІДМОВ» ЯК МЕТОД ЗАПОБІГАННЯ АВАРІЙ В ЕНЕРГЕТИЧНОМУ ГОСПОДАРСТВІ ХАРЧОВОГО ПІДПРИЄМСТВА

Національний університет харчових технологій
Київ, вул. Володимирська 68,01601

Siryc A.O., Evtushenko O.V., Yefisko Y.Y., Ovcharova D.A.

ANALYSIS OF THE EFFECTIVENESS OF USAGE THE "FAULT TREE" METHOD FOR THE PREVENTION OF FAILURES IN THE POWER ECONOMY OF FOOD PROCESSOR

National University of Food Technologies
Kyiv, Volodymyrska str. 68,01601

Анотація. В роботі розглядаються причини небезпечних подій на енергетичних об'єктах підприємств харчової промисловості та запобігання їх за допомогою методу «Дерева відмов».

Ключові слова: охорона праці, аналіз, небезпечні події, моделювання

Abstract. The topic of the paper is the reasons of hazardous events at the power objects of food processing units and their prevention using the "Fault tree" method.

Keywords: labor protection, analysis, dangerous events, modeling.

Introduction.

Occupational health and safety management system (OHS MS) is a part of general system of enterprise management. With the automated systems, labor protection management is a part, or a subsystem here. Labor protection management needs almost all services and subdivisions of the enterprise participating in it. Their activity is defined with the Occupational Health and Safety Regulation.

Most of the food processors of Ukraine, using power facilities of the country, are still tooled up with old technical equipment of Soviet times, which is too old to be used safely. Such equipment can be main reason of failure or occupational accident on enterprise.

Power economy of food processing factories is a dangerous industrial object, as many accidents with heavy consequences happen there. Power economy complex contains explosion and fire hazardous and toxicant devices and equipment. Therefore, quantity of failures in the tank battery and in the pipes grows. For liquidation and – mainly – for prevention of such accidents, it is necessary to evaluate the risk of breakdowns and their consequences.

The main part.

The reasons of dangerous events at the power units of the food processing enterprises can be divided into organizational and technical ones. The main factors of rise and development of such events are dissatisfactory condition of technical devices, buildings and constructions, imperfection of technologies or design flows. Organizational reasons include: irregularities in the procedure of work performance, incorrect organization of work performance, ineffectiveness of manufacturing supervision, intended safety, alarm and contact equipment shutdown, low level of knowledge of the demands of industrial safety, operational misconduct, and reckless (unauthorized) actions of workers.

About 70% of accidents and failures are caused by organizational reasons, coming from the human (operator) mistakes and human factor influence.

The detailed analysis of traumatism accidents among workers of the power economy of food industry proves that the process of their development and rise is characterized, as a rule, with the logic connection of casual events which appear on

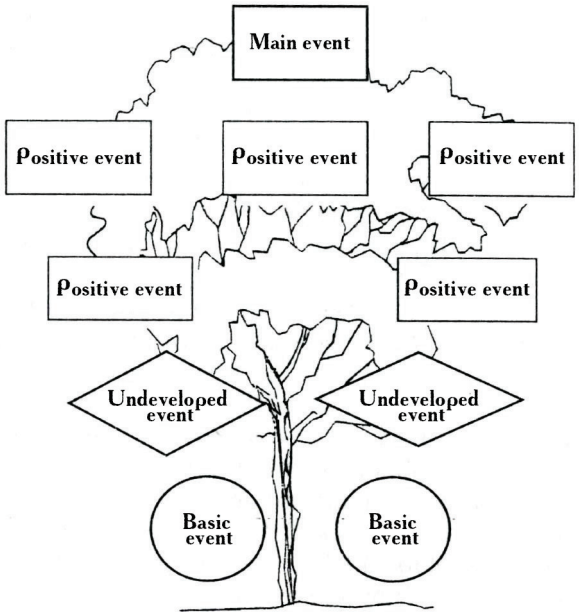
the different stages of the emergency process or irregular situation with different frequency.

It is opportune to use logic-imitating modeling based on the method of the "Fault tree" for the signification and studying the logical connections between these events, for their quantitative evaluation and analysis.

If the crisis or emergency situation happens on the enterprise, managers or responsible persons have to react momentarily, as the delay of the decision-making or wrong decision can cause negative consequences. In most cases, important decisions in crisis situations can be incorrect because of managers' unawareness about the system of processing: how would the concrete decision influence the factory functions; therefore, chain reaction happens causing breakdown of the major equipment or even occupational failure.

Modeling at the method of the "Fault tree" provides taking into account different operational factors about the machines reliability, professional qualities and psychophysiological features of the operator, and the condition of the operating environment, that form primary (basic) events-hazards, with their later transgression into intermediate events, which, with some circumstances, form the main event-consequence. Taking into account all these factors existence, we build logical model of running the traumatism-hazardous process with the later investigation of its major characteristics (pic.1).

In some cases, evaluation of system reliability can be presented as a multistage process, with each previous condition having several next ones.



Pic. 1. System of the development of the «Fault tree» [6]

The event can be realized after one or several steps on the way to the final (root) event. Having huge amount of finals and steps, it is too difficult to count all the conditions. This process can be taken into order and simplified to the mechanical operations with the help of the "final tree" building. Absolute probability of each result is defined as product of all probabilities marked on the tree limbs, starting from the concrete result and finishing at the root of tree (its basic condition).

The “Fault tree” building begins from formulating the final message about the system breakdown (full stop of the processing). To characterize the reliability of the system, final message is connected with the event, which caused functioning failure in the explored time interval, with the specified criteria.

The “Fault tree” method is the most general one, used for giving logic of breakdowns of technical systems. It is given in the form of graphic hierarchical system, which, using edges of graphs and logic operators AND, OR (which mean product and sum of the events), connects failures of elements with the breakdown of the object.

Failures – basic events – are the events, related to the collapse of system’s elements, unavailability of the equipment because of maintenance, trials or other circumstances, personnel’s mistakes, which may provoke the undesired event. The “Fault tree” is the model of different parallel and sequential chains of failures, forming the realization of preliminary defined negative event.

Method of the “Fault tree” is based on the deductive analysis of failures; it gives the possibility to define the undesired condition of the system (failure rise), analyze the system taking into account the conditions of exploitation for finding out all the possible scenarios of the negative event’s development. Therefore, the “Fault tree” shows logical interconnections of basic events, followed by negative event, situated in the top of the tree. The “Fault tree” schemes accurately define logical combinations of basic events leading to the top event (pic.1).

Building the tree of failures and incapable conditions assists to the detailed analysis of reasons of failures, and to the development of the most effective measures for their elimination. Such analysis is made for each period of functioning, for each element or the whole system. It is one of the means to define reliability of anthropogenic systems, which is connected with the evaluation of risks of natural and anthropogenic character. Such approach is getting widespread in Europe, in the evaluation of anthropogenic hazard of many activities. It is considered, that guideline SEVEZO II, having wide covering, integral character and direction into the prevention of breakdowns, helps to create some base for more effective regulation of situations, connected with risk [6].

Methods of analysis of risk of industrial factories differ with their extremely high labor intensity, data indeterminacy and existence of subjective feedbacks. One of the main problems of modeling failures and processes of their development is connected with the necessity of automation of building models and realization of variable calculations for studying the scenarios of failure situations development. That allows to lower the subjectivity of experts’ conclusions.

Technique of usage of this risk evaluation method is described in modern scientific and technical literature and regulatory documents [2, 3]. There are software solutions, which allow to automatize the procedure of getting risk evaluations with this method [5].

Let us look at the objective approaches usage while building the “Fault tree” for boiler units working at the fluid fuel.

Exploitation of boilers on the fluid fuel demands huge experience and attention of operators. Inattention or mistake while directing the fuel regime may cause heavy

consequences. Operator has to know and take into account dangerous qualities of combustion gases, meaning their explosive-hazardous character.

The most widespread reasons of forming the explosive-hazardous gas-air mixture are: lack of airing of fireplace and gas-pipes; supply of gas to the igniter before the initiating impulse importation or formation; flame-out of mobile ignition source in the fireplace at the igniters switching; attempt of flaming the neighboring igniter from the working one without the inflammatory flare use; repeated switching on the igniters after the flame-out of inflammatory or main flare without the preventive airing of the fireplace and gas-pipes; incorrect or ill-timed opening of taps before the igniters; incorrect airing of the gas-pipes before setting the boiler to work [4].

With the incorrect rating of boilers on fluid flow, which means destabilization of burning (lift or flashback of fire at the rapid changes of rating, defects of gas-igniting, draught and stabilizing devices, damages of gas and air pipes etc.), explosive-hazardous gas-air mixture can appear in the fireplaces, gas-pipes and flues. If its temperature reaches the temperature of deflagration, the explosion of mixture comes possible, no matter whether it happened in full volume or part of it.

Widespread reasons of boilers breakdowns are: mechanical damage of pipes, irregularities in the procedure of airing, lowering of the water level, gaps of water treatment, overregulatory augmentation, pollution of boiler water, non-following the procedure of warming, lowering pressure to vacuum of storage in inappropriate conditions, fuel explosion [1].

Fuel explosion is one of the most hazardous situations in the exploitation of boilers. The reasons for most of the explosions are bad fireplace cleaning or oversaturation of gas-and-air mixture, which appears in the unburnt fuel concentration in the fireplace.

Methods of analysis of industrial productions' risk differ with their high labor intensity, lack of data determinacy and existence of subjective feedbacks. One of the main problems of modeling failures and processes of their development is connected with the necessity of automation of models building and realization of variable calculations for studying the scenarios of the failure situations development. It allows to lower subjectivity of experts' conclusions.

Modeling by the method of the "Fault tree" involves taking into account different production factors about the machines reliability, professional qualities and psychophysical features of human-operator and condition of the industrial environment, which form primary (basic) events-hazards, with their further transgression into intermediate events, which form then, with some circumstances, main event-consequence. Taking these factors into account, we build the logical model of traumatism-hazardous process development with further investigation of its main characteristics.

We demonstrate the example with a piece of model of conditional traumatism-hazardous process at the maintenance of boilers, working on the fluid fuel, on the pic. 2, where the main event A (traumatism of personnel, stoppage of power economy, stoppage of manufacturing process on food processor) with the help of «AND»-operator is divided into intermediate events Y1, Y2 and X (thus, explosion of vessel

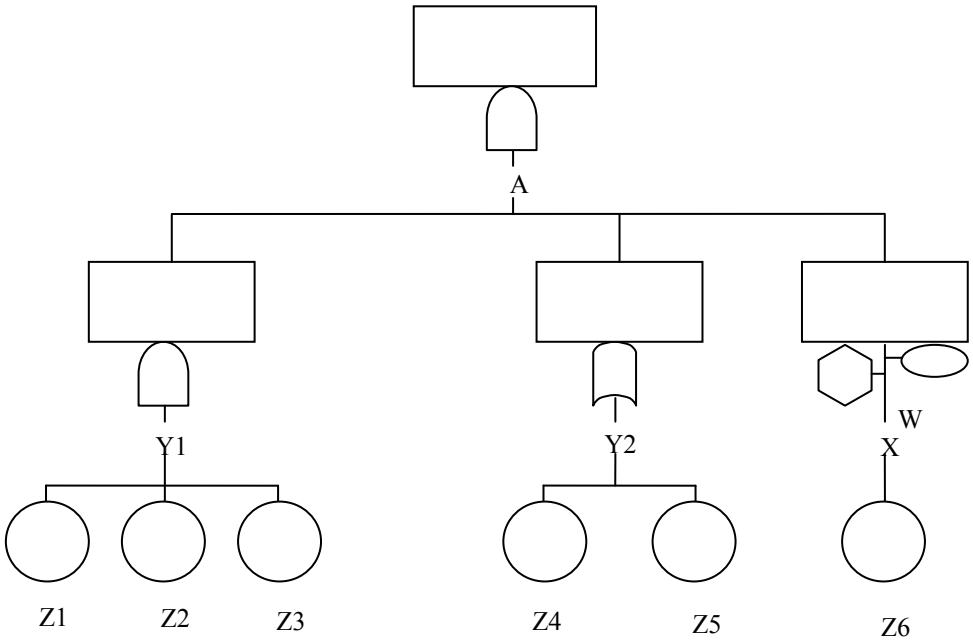
which works under pressure; pipes destroy; air pollution). These ones, by the same token, using operators «AND», «OR» and «TABOO», are divided into primary events: Y1 – into Z1, Z2, Z3, (personnel mistakes, disturbance of operating regime); Y2 – into Z4, Z5 (non-following rules of occupational safety); X – into Z6 and W (incorrect decision-making in the situation of failure).

Using rules of logic algebra, we write formula for the description of traumatism-hazardous process development at the maintenance of boilers which work on the fluid fuel, taking into account logical content of events' interconnections:

$$P_A = P_{Y1} \cap P_{Y2} \cap P_X = (P_{Z1} \cap P_{Z2} \cap P_{Z3}) \cap (P_{Z4} \cup P_{Z5}) \cap P_{Z6} \cap P_W$$

Giving the logical connections algebraic content, we write formula for definition of the probability of happening the undesired consequence:

$$P_A = P_{Y1} \cdot P_{Y2} \cdot P_X = (P_{Z1} \cdot P_{Z2} \cdot P_{Z3}) \cdot (P_{Z4} \cdot P_{Z5} - P_{Z4Z5}) \cdot P_{Z6} \cdot P_W$$



Pic. 2. A piece of model of conditional traumatism-hazardous process at the maintenance of boilers, working on the fluid fuel

Therefore, the "Fault tree" method provides realization of deep analysis of probability of hazardous situations rise at the maintenance of boiler units, which are the elements of power economies of food processing enterprises, and demonstrates decomposition of events, which influence the rise of the main event-consequence. It is the instrument for qualitative and quantitative analysis of the investigated events, and for definition of their main characteristics, in particular, for the quantitative evaluation of levels of occupational risk of boilers operators at their maintenance.

The analysis of the "Fault tree" is valuable because of several reasons: it eases analysis of complex systems reliability; gives the possibility to throw the unreliable places into sharp relief; gives the possibility of qualitative and quantitative analysis of system's reliability; allows specialists to concentrate on separate concrete system's failures in turn; provides objective information about the system behavior and

specialties of work.

The major efficiency of the “Fault tree” method, comparing with other methods, is in the limitation of analysis with finding out only those elements of system and events, which assisted to the concrete failure of the system or its breakdown [5].

Deficiencies of the “Fault tree” method are: time and expense needed for its realization; the «Fault tree» is a logical scheme, which allows only two states: working and failure; difficulties in considering the condition of partly elements failure, as it decides that system condition is either working or failed; difficulties with analytical decision-making for the trees containing reserve and recovery assemblies with priorities, and with the calculation of multiple failures; reliability experts need to have deep understanding of specialties of system functioning and to study failure of one concrete function; the “Fault tree” describes the system in the concrete moment of time (usually in stale regime) and shows that circumstances sequence is sometimes impossible.

To find and demonstrate causative connection with the help of the “Fault tree”, you need elementary blocks, subdivisions and connections of huge amount of events.

Elementary automation of power systems control by the modern principles can eliminate the problem of peak ratings. Effective organization of manufacture means uniting of all the cycle of provision, marketing, calculations and management into it, while in the existing system we don’t have necessary connections, common consumers and common operators’ management. Provision of constant maintenance of the equipment and its well-timed service may prevent breakdowns on the enterprise.

The «Fault tree» will help to foresee possible breakdowns and failures in the manufacture. It will also help manager to choose the right action of further reacting in the alike situations.

Therefore, well-timed discovery of hazards on the enterprise and development of plan and measures for elimination of production accidents will assist to managers handle with such cases better and faster. This will do with the help of creation of system for the prevention of some elements of the equipment failures. These measures will save the employees from the occupational traumatism and improve occupational safety at the enterprise.

References:

1. Kopei B.V. Vykorystannia «dereva vidmov» yak metodu strukturnoho analizu shtanhovoi nasosnoi ustanovky /B.V. Kopei, V.B. Kopei, O.R. Martynets, O.I. Stefanyshyn, A.B. Stefanyshyn // Rozvidka ta rozrobka naftovykh i hazovykh rodovyshch. – 2013. – № 2(47). – S. 62-71.

2. Averin G.V. Analiz opasnostej ammiachnyh kompressornyh ustanovok metodom postroenija «dereva otkazov» /G.V. Averin, V.M. Moskalec // Ekologichna bezpeka. – 2008. – 3-4. – S. 9-16.

3. Mozhaev A.S. Programmnyj kompleks avtomatizirovannogo strukturno-logicheskogo modelirovanija slozhnyh sistem (PK ASM 2001) / A.S. Mozhaev // Trudy Mezhdunarodnoj Nauchnoj Shkoly «Modelirovanie i analiz bezopasnosti, riska i kachestva v slozhnyh sistemah». SPb.: Izdatel'stvo OOO «NPO «Omega». – 2001 –

S. 56-61.

4. Clinciu, M.R. Using the fault tree method for reliability analysis of a cold monojet water meter / M.R. Clinciu// Bulletin of the Transilvania University of Braşov. – 2014. – Series I, Vol. 7 (56), No. 1. – P. 19-24

5. Hohitashvili H.H. Upravlinnia okhoronoiu pratsi ta ryzykom za mizhnarodnymy standartamy: Navch. posib. / H.H. Hohitashvili, Ye.T. Karchevski, V.M. Lapin// – K.: «Znannia», 2007. – 367 s.

6. Levchenko V. Vykorystovuvaty nabutyi dosvid pry rozsliduvanni avarii ta neshchasnykh vypadkiv / V. Levchenko // Okhorona pratsi. – 2000. – № 6. – S. 27-29

7. Litvinov V. V. Udoskonalennia metodu otsiniuvannia nadiinosti skhem releinoho zakhystu / V. V. Litvinov, Ya. S. Sachenko // Elektrotekhnika ta elektroenerhetyka. – 2015. – № 1. – S.62-68.

8. Rozrakhunok nadiinosti elektrychnoi merezhi na osnovi pobudovy dereva vidmov: Elektronnyi resurs [Rezhym dostupu] – http://ukrbukva.net/page,2,69121–Raschet–nadezhnosti–elektricheskoiy–seti–na–osnove–postroeniya–dereva–otkazov.html

Стаття підготовлена в рамках Програми виконання Держбюджетної науково-дослідної роботи № ДР 0115U003534 НУХТ

Стаття відправлена: 06.04.2017 р.

© Siryc A.O., Evtushenko O.V., Yefisko Y.Y., Ovcharova D.A.

ЦИТ: ua117-016
DOI: 10.21893/2415-7538.2016-05-1-016
УДК 669.017.3

Карпова Е.Ю., Кушнаренко М.А., Гасымов Р.В.

ИССЛЕДОВАНИЕ УСЛОВИЙ ФОРМИРОВАНИЯ ОСНОВНЫХ ВИДОВ ДЕФЕКТНЫХ СТРУКТУР В ЛИТОЙ СРЕДНЕУГЛЕРОДИСТОЙ СТАЛИ

Волгоградский государственный технический университет
Волгоград, просп. им. В.И. Ленина 28, 400005

Karpova E.Y., Kushnarenko M.A., Gasimov R.V.

INVESTIGATION OF CONDITIONS OF FORMATION OF MAIN TYPES OF DEFECTIVE STRUCTURES IN CAST INTERMEDIATE-CARBON STEEL

Volgograd State Technical University
City of Volgograd, ave. Lenin, 28, 400005

Аннотация. В работе рассмотрены возможные причины снижения механические и эксплуатационные свойства отливок из среднеуглеродистой стали вследствие формирования неблагоприятной структуры, которая характеризуется большим размером зерен, расположением феррита по границам зерен в виде сетки и нередко с образованием игл видманштеттова феррита.

Объектом исследования была литая среднеуглеродистая конструкционная сталь 45Л. Предметом исследования являлись изменения структуры и свойств этой стали в литом состоянии и после термической обработки.