

INFLUENCE TECHNOLOGICAL PROCESSES ON CHANGE OF THE CHEMICAL EQUIPMENT TECHNICAL CONDITION

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It is offered to take into account the influence of technological and degradation processes arising at the chemical manufactures equipment operation under action of external and internal factors. It allow to predict a technical condition of objects more precisely.

One of most effective methods of the analysis of the change of the equipment technical condition is the system approach [1,2]. This method consists in decomposition of system, i.e. its representation as aggregate of elements and connections between them. Such approach has a number of advantages and allows to define a condition of each element and all system.

It is known [3,4], that during the work the technical condition of the equipment is changing. Results are deterioration of equipment parameters, infringements of serviceability, occurrence of refusals and finally its stop and failures and other events negatively influencing on man-caused safety.

The chemical manufacturing equipment has a number of features, which define specificity of its technical condition change. First of all, it is presence of a lot of technological processes which exert determining influence on the equipment changing its parameters in the course of time, worsening its work and causing new degradation processes. The account of technological and processes influence on technical condition change of the chemical manufactures equipment is better realized by means of the system analysis.

Thus, the purpose of work is research of influence technological and degradation processes on the condition change of the chemical industry equipment on the basis of the system approach.

Let's consider the equipment as system (figure 1). For simplification we shall consider system in which details are elements. In conformity with principles of the

system approach between the elements connections operate. Besides there are external connections, they are called inputs and outputs which are established with elements of other systems.

Change of the technological object properties

in consequence of processes

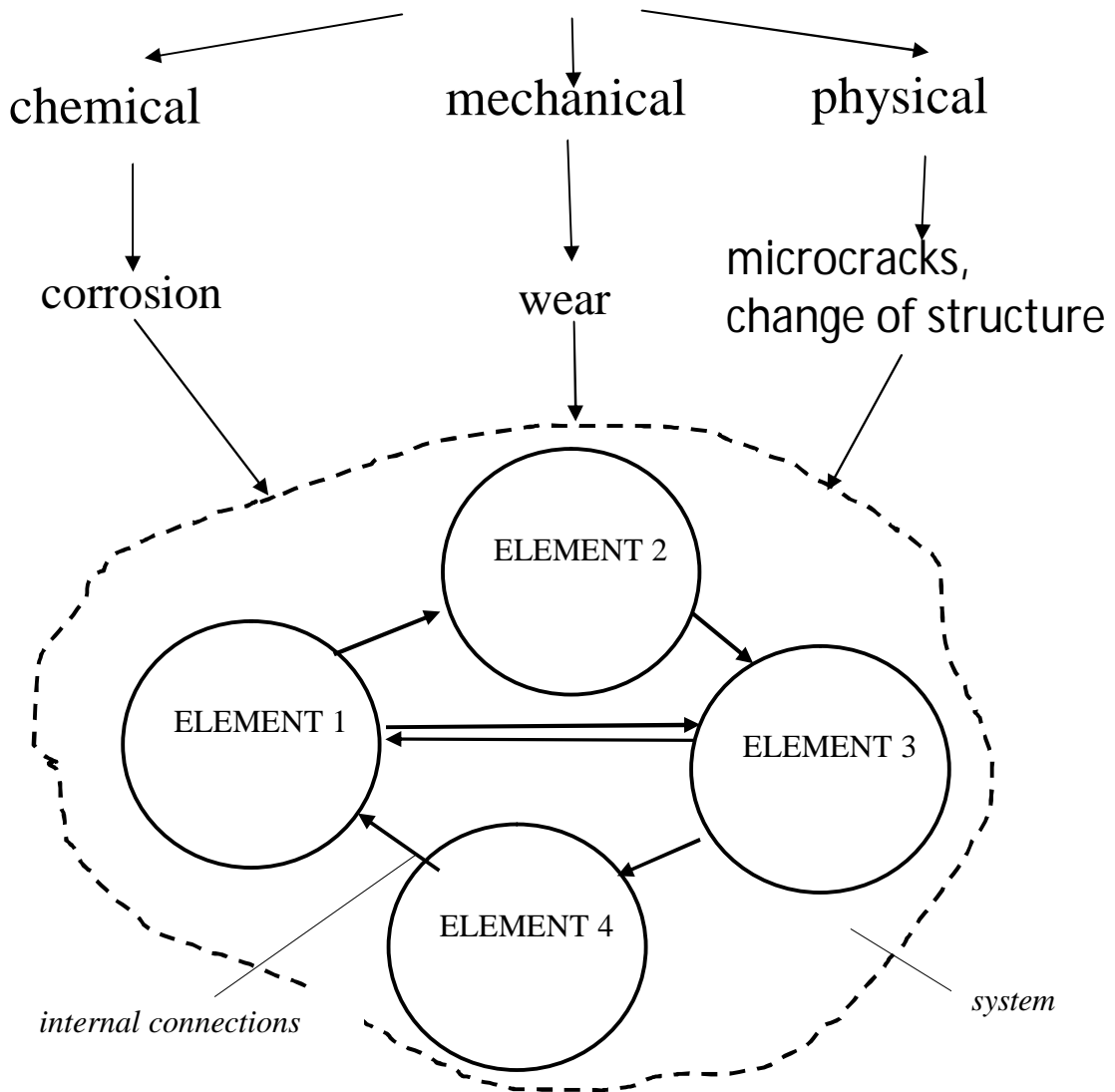


Figure 1 - Representation in a system kind

Each of listed constituent (elements, connections, external connections) has properties which characterize object as a whole and parameters which are shown in different processes. All properties and parameters classify by their nature. There are

distinguished chemical, geometrical, physicomachanical, thermalphysic and other properties and parameters.

To the properties describing an element as a whole it is possible to attribute: a weight of the detail, an overall dimensions, a material, a density, a factor of temperature expansion, a thermal diffusivity, etc. To properties of a surface as component, we refer the linear and angular sizes, a roughness of a surface, profile tolerances, a hardness and etc. To properties of edges it is possible to attribute the sizes, profile tolerances, etc.

Examples of properties and parameters of an element and its components are resulted in table 1.

Table 1 - Properties of an element and its components

Kind	Properties	Dimension
ELEMENT		
Chemical properties	- material; - chemistry.	- -
Geometrical properties	- linear dimensions; - angularity; - volume.	m radian m ³
Thermophysical properties	- thermal-conductivity coefficient; - heat-transfer coefficient; - calorific efficiency; - thermal-expansion coefficient.	Wt/(m*K) Wt/(m ² *K) Wt/(m*K) 1/K
Physical-mechanical properties	- mass; - density;	kg kg/m ³
COMPONENT (surface)		
Geometrical properties	- linear dimensions; - angularity; - roughness; - square; - profile tolerances.	m radian - m ² -
Physical-mechanical properties	- hardness; - peculiarity of the processing (tempering, strengthening, cementation, nitration and others).	HB -
COMPONENT (arris)		
Геометрические	- linear dimensions; - profile tolerances.	m -

The values of parameters depend not only on object, but are substantially defined by those processes in which they are shown.

In the manufacturing equipment some processes are the basic and are caused purposely, for example, drying, having heated, cooling, mixture, pressing, crushing, and others. Such processes are called technological processes. However, along with technological processes inevitably there are processes which negatively influence the equipment and on technological processes. For example, there are fatigue and corrosion processes, wear process, the damages accumulation processes. These processes are called degradation process (2).

It is known that all processes are caused by working factors (driving forces). Thus, under action of factors there are processes which operate both on the elements, and on their components, causing change of its properties and parameters. Factors can be divided on internal (an interaction of elements, a friction) and external (a temperature, an external loadings (pressure, force, the moment), the corrosion environment). Let's consider some variants of the schemata of the factors actions , occurrence of processes and changes in system (figure 2).

1. In the elementary case (figure 2) the external factor causes technological or degradation process which, operating on the element or its components, causes properties changes.

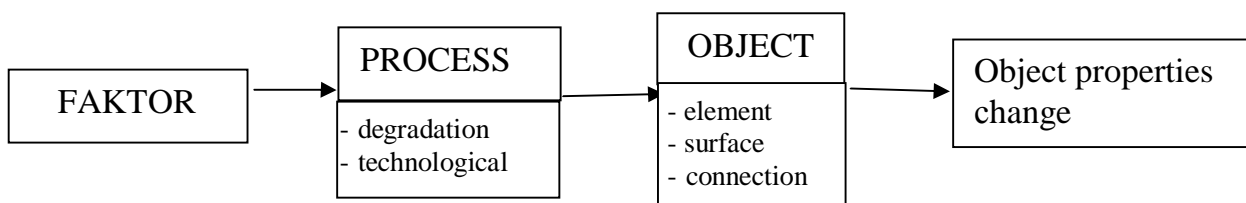


Figure 2 - The process approach scheme

For example, influence factor is the temperature then it causes process of heating which results in change at the element of the such properties as thermal conductivity, strength, elasticity, etc. Or the influence factor is the moving working environment which causes process of wear process that results in change at an

element of such property as thickness of a wall. When properties change exceeds allowable value, there is a failure or the element refusal .

2. The scheme can be more difficult, when the one element properties change can result in the other properties change.

For example, the influence factor is chemically active environment. It causes corrosion process to result in the element properties change such as the wall thickness of loaded detail, that in turn results in change of working pressure (other property of object). The chain of consistently caused changes of properties, in some cases, can be continued.

3. In some cases, element properties change can result in occurrence of new system elements called defects.

For example, the influence factor is chemically active environment, it causes the corrosion process (ulcer, dot corrosion) which results in such element property change as a wall thickness and conducts to defect formation - a through aperture. Or the influence factor is the temperature, it causes the process of local heating which results in the such element property change as wall thickness and conducts to defect formation - a burnout.

4. The continuation of the previous case can be variant with accumulation of defects when their quantity or parameters values exceed allowable value and cause new process occurrence.

For example: the influence factor is interacting surfaces contact. It causes process of wear process which results in change at an such element properties as the surface roughness, deviations of the form and conducts to defect formation - a through aperture, that in turn results in occurrence of the such new processes as a rotations unevenness , a beating, a vibrations.

5. In some cases the object properties change results in change of the processes taking place in the object. This case is most distributed for the chemical manufactures equipment.

For example: the pipeline walls thickness change (passageway reduction) results in the change of the process of the liquid current (the speed change); it results in change of the heat transfer processes.

6. One more possible variant is the continuation of the previous case when the object properties changes cause the technological processes changes. That results in change of working factors, and in some cases, in occurrence of the new factors not inherent in normal equipment work.

For example: proceeding chemical reactions change can result in sharp rise in a temperature or a pressure.

Examples of the factors, the processes and the changeable properties of the object are resulted in table 2.

The offered schemes are a pattern at the creation of the factors action schemes, the processes occurrence and the changes in system for the real equipment. For this purpose it is necessary the corresponding maintenance development including the database of the possible working factors, technological and degradation processes, the geometrical models of the system elements, and also mathematical models the describing offered scheme in each concrete case.

Table 2 - Examples of factors, processes and changeable properties of objects

FACTOR	PROCESS	CHANGEABLE PROPERTY
Temperature	Heating	The element thermophysical properties (thermal diffusivity, diffusivity, heat capacity etc.).
	Thermal expansion	Heat stress, deformations, profile tolerances.
Hostile environment	Corrosion	Element thickness, surface roughness, profile tolerances.
Load	Rise of strains and deformations	strength, harshness, profile tolerances.
Friction	Frictional wear	Proportion, surface roughness, profile tolerances.

Besides it is necessary to take into account, that all offered schemes and the corresponding models should be realized in view of the time factor since all processes proceed in time. It will allow to take the technical state for the predetermined time moments for all elements, connections and accordingly system as a whole.

Literature

1. Chemical process safety: fundamentals with applications, 2nd edition (2002):
By Daniel A. Crowl and Joseph F. Louvar, Prentice Hall PTR, Upper Saddle River,
NJ, pp. 642
2. Губанов А.А., Захаров В.В., Коваленко А.Н. Введение в системный анализ: Учебн. пособие. Под ред. Л.А. Петросяна – Л.: Издательство ленинградского университета, 1988 – 232 с.
3. Белов П.Г. Теоретические основы системной инженерии безопасности. М.: ГНТП «Безопасность», 1996. – 424 с.
4. Надежность технических систем и техногенный риск/ Акимов В. А., Лапин В. Л., Попов В. М. и др. М.: ЗАО ФИД «Деловой экспресс», 2002 - 368 с.