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FIXED TUBE GRATE HEAT EXCHANGER REPAIR PROBLEMS

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Abstract
The article presents the problems in the repair of heat exchangers with a fixed tube grid and ways to solve them. The operating modes are analyzed and the methods of maintaining and repairing them are shown.

Keywords: Heat processes, heat exchange, operating modes, operation and maintenance, pipe networks, pipe cleaning, shell cleaning, internal surface, heat transfer coefficient.

Introduction

Most processes in the chemical industry involve heat and various heat exchangers are used to carry out such processes. To increase production capacity, heat exchange devices must be efficient, simple, and not have a negative impact on product quality, and the cost of manufacturing the heat exchangers must be low. To solve such issues, it is necessary to take into account the acceleration of heat exchange processes during the implementation of basic processes and during repairs [1-3].

Accelerating thermal processes leads to increased productivity of equipment, reduced size, and reduced floor space in production rooms. This, in turn, reduces the cost of operating and adjusting thermal equipment, increases the amount of output per worker, and so on.

Accelerating thermal processes reduces the time required to heat the material, but this should not lead to a decrease in product quality [4-7].

Research Objective

To address the issue of repair. When analyzing the operating modes of heat exchangers at Indorama Ferganaazot JSC, it was determined that the main issue is maintaining and repairing them in working condition.

Our analysis and literature data show that shell-and-tube heat exchangers are the most common type of heat exchanger.

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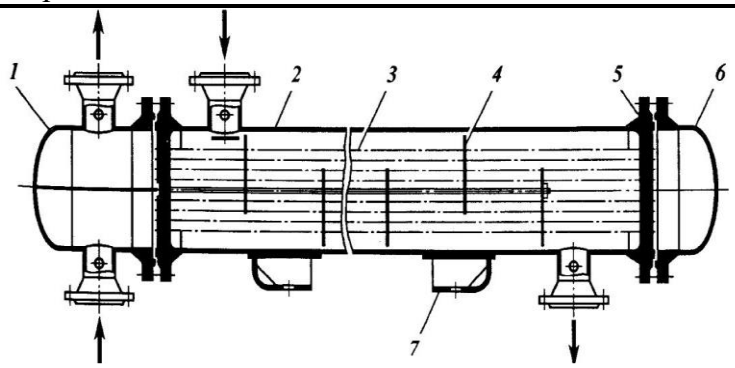
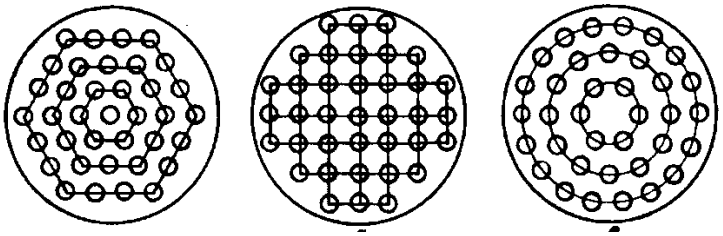


Figure 1.1. Fixed tube grid heat exchanger.

1-distribution chamber, 2-shell, 3-pipe, 4-transverse barrier, 5-pipe mesh, 6-shell cover, 7-support.



a **b** **v**

Fig. 1.2. Methods of placing pipes in pipe grids:

a) along the edges of a regular hexagon (38); b) along the sides of the square (32): v) along concentric circles (36).

Research methods

The main requirement for placing tubes in a grid is the minimum inter-tube space. Based on this requirement, the methods of placing tubes are given in Figure 1.2. In shell-and-tube heat exchangers, the tubes should be placed along the edges of a regular hexagon. In this case, the pipes will be compactly arranged, their number and heat exchange surface will be more. To make it easy to clean the surface of the pipes, it is appropriate if the pipes are placed on the grid along the square sides.

To achieve a high heat transfer coefficient in the device, the velocity of the heat transfer agents should be 8-30 m/s for gases and at least 1.5 m/s for liquids.

Depending on the specific configuration and construction of the devices, different methods are used for repair. In this process, it consists of identifying defects in the pipe, shell and pipe mesh (set), inspecting and replacing corroded pipes [8-12].

Cleaning the internal surfaces of heat exchangers is carried out according to a clearly defined procedure: mechanical methods; cleaning with water and steam; cleaning methods using various solvents. Therefore, a specific cleaning method is selected for a specific heat exchanger.

The science of thermo-technology deals with repair problems. This science systematizes the principles and elements of technical inspection and repair of technological equipment, taking into account moral obsolescence. It combines the processes of design, installation and operation of equipment [12-18].

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During operation, the parts of the equipment are subject to wear, deformation and corrosion under the influence of external and internal stresses. This wear is accompanied by a change in the size and shape of the part, as well as a change in the mechanical and chemical properties of the external and internal layers of the part.

When this wear reaches a certain limit, it is called operational failure of the part. This defect is eliminated by repairing or replacing the part.

Results

According to the technological regulations at Indorama Ferg'onaazot JSC, the current repair process of the heat exchanger is carried out as follows:

1) remove the device from the technological line and disassemble it into parts;
2) clean the pipe surfaces;
3) check the tightness of the pipes;
4) plug the leaky and defective pipes with a plug;
5) check and renew the seals of the joints;
6) assemble the device and check for tightness;
7) check the operating modes of the device.

In the manufacture of heat exchangers and machines, materials should be selected according to the application specifications, taking into account the conditions affecting the materials, the temperature, and the resulting chemical technological process that will change their physical and chemical composition.

The material should be selected knowing the operating conditions (temperature, pressure, concentrations of the phases in contact).

When choosing a material, it is necessary to take into account its mechanical composition and properties: yield strength, strength, elongation, hardness, processability, weldability, chemical resistance to corrosion, thermal conductivity, etc. For example, the mechanical properties of the material from which the working equipment is made change at low temperatures.

There is also a need to weld the material, because welding is the main method of attaching equipment in modern chemical technology.

Figure 1.3. Appearance of the pipe network requiring repair.

The main requirement for the material of heat exchangers is its resistance to corrosion, since it determines the long-term durability of chemical devices. The aggressiveness of the conditions can increase or decrease depending on their concentration.

When selecting materials for ferrous and non-ferrous metals or alloys for the apparatus, the corrosion resistance of metals under constant corrosion conditions is taken according to GOST 13819-68. For the manufacture of chemical devices, structural materials should be used whose corrosion rate does not exceed 0.1-0.5 mm/year. Materials with a corrosion rate of 0.01-0.05 mm/year are often used.

The specific conditions of operation of heat exchange devices, characterized by a wide pressure range and aggressive environmental temperatures, impose the following requirements on structural materials.

- High chemical and corrosion resistance of materials in aggressive working environments;
- High mechanical strength under static loads, operating pressures and temperatures resulting from the use of hydraulic impact devices and equipment;
- Good weldability of materials to ensure high mechanical properties;
- The material is cheap and non-tankish.

Taking into account the technological process and weather conditions, there should be a guiding principle in the design of technological equipment and facilities in the chemical industry. The use of open facilities in industry has been confirmed by foreign practice. The location of the main parts of technological departments in open areas is not considered an obstacle.

Ensuring the security service of the heat exchanger in the placement of the equipment, creating convenience in the cleaning of the transport and people's movement paths, i.e. the working surface of the equipment. The light paths of the service front are taken one meter (in the parts of the enlarged hill between the equipment, the peak and the constructions).Даврли хизмат учун йўл эни 1 метр олинади. For periodic maintenance, the width of the path is taken as 1 meter. It is necessary to place the crane for lifting machines and equipment close to the hook. In this zone, areas and paths should be considered for placing the details of the transported equipment. The dimensions of the path and area are determined by the dimensions of the large heat exchanger. When the space between the devices, that is, between the walls of the rooms between the devices, is to be used, the lighting distance is taken as 1 meter.

Placement of equipment working under high pressure and approved by the State Technical Control comes from the "rules for construction and safety use of pressure vessels". The elimination of the possibility of dropping the devices should not violate the strength and durability of the staircase and platform construction devices, ensuring access to all parts of the device; the possibility of control; external and internal repair; protection of the device from corrosion; maintenance; and convenience of repair. Lifting and transport vehicles are placed in buildings and areas for installation, operation, dismantling and repair.

The selection of these locations is carried out based on the characteristics of the equipment being placed, the number of units, the period of repair work, its duration, etc.

While it is recommended to use electric forklifts, forklifts, cranes, and other simple equipment to perform repairs on equipment located in buildings, it is also advisable to use truck-mounted pneumatic cranes to repair equipment located in buildings.

For technological services of loading and unloading (catalysts and wheels) of large quantities and various types of equipment located in open areas and requiring frequent disassembly and dismantling, it is necessary to use high-altitude cranes. In order to maximize the use of tower cranes for lifting loads, it is necessary to place heavy equipment closer to the crane and light equipment further away.In this case, in order to reduce the cost of servicing a number of devices, it is necessary to use a tower crane at a closer distance to increase the efficiency of the tower crane.

The size of the external location in width is determined by the boom height of the tower crane. Cranes, crane-hammers and monorails are used in buildings for repair, operation and assembly of equipment.

It is recommended to use a crane-sledgehammer in low-rise buildings only when lifting devices are required during the installation of the equipment and not necessary for the operation and repair of the house. A crane-hammer is used for lifting heavy loads (from 0.25 to 5 tons) and small lifting of buildings.

There are two types of cranes - bridge and hanging. Overhead crane - the beams move on steel rollers guided by beams. The difference of hanging crane beams is that they are allowed to be used in buildings of light construction, and in case of growth, the details of the equipment can be fixed.

Equipment located in open areas reduces costs, reduces gassing, reduces fire and explosion safety, helps the size of aggregates, allows for division into parts in many cases, and also improves equipment installation conditions.

If the production is dangerous and the raw materials and products related to it have smelly, flammable properties, a complex forced system, multiple air exchange ventilation per hour is required for its use.

Special requirements are imposed on production facilities at “Indorama Ferganaazot” JSC. The enterprise produces ammonia, weak nitric acid, ammonium nitrate, urea, and caprolactam. The location of their facilities in an open area is of great importance.

The use of mobile construction machines significantly reduces the volume and area of buildings in production. Circulating piston compressors are used in the production of nitrogen fertilizers and ammonia. In the new method, it would be appropriate to use compressors moving along a circulating center installed in an open area.

When placing technological equipment, it is necessary to design it in “Indorama Farg’onaazot” JSC. If weather conditions and operating conditions of the technological device allow, there may be canopies to cover the upper part of the equipment, only one surface, in some cases a shelf.

These surface mounts are only used if the device is not a hot room device, but the devices must have the same resistance to wind, dust, and rain as the workers.

Placing small diameter and high height devices on shelves:

- all heavy and bulky equipment should be placed in such a way that it does not overload the structural supports;
- standard support structures made of reinforced concrete;
- large-sized devices - covers, fittings, fittings, etc. are attached to the device itself.

In turn, it is used to place auxiliary equipment for heat exchange and others in the areas. Placing the devices in other devices or technological equipment significantly reduces the area of the device. Such placement is purposeful, because the pipe equipment is shortened, hydraulic losses are significantly reduced, and the geometric properties of the equipment are increased. The placement of equipment in open areas requires compliance with the rules and regulations of technical safety, fire safety, the removal of equipment to open areas, and other rules and regulations, decisions, ensuring good conditions for workers and the safe operation of equipment.

Conclusions

In a fixed tube-fin heat exchanger, the fixed tube fins are rigidly connected to the shell. Their main disadvantage is that they cannot withstand temperature stresses and the internal surfaces of the shells and the external surfaces of the heat exchanger tubes cannot be mechanically cleaned of dirt and deposits. The restoration of such heat exchangers by assembly and repair is somewhat limited.

That is why its long service life is ensured only by strict adherence to the appropriate operating regime. For example, the temperature difference between the heat-exchange media specified in the device passport cannot be exceeded, as this can lead to damage to the pipe-to-pipe joints or pipe rupture. One of the two heat-exchange streams, free from impurities, corrosive active substances and suspended particles that impair the heat exchange process and increase the hydraulic resistance of the device, is sent between the pipes.

It should be noted that it is not possible to inspect the outer surfaces of the pipe and the inner wall of the device shell, which means that it is impossible to monitor the condition of the device during operation.

There is experience in cathodic protection of pipeline and heat exchanger shells from corrosion using seawater. Such protection reduces the corrosion rate by 5-6 times. A certain number of elements subject to cathodic protection, depending on the size of the protected surfaces, are hung inside the device cover; depending on the extent of corrosion, the elements can be regularly replaced with new ones during installation and repair.

References

1. Tojiyev R.J., Tojiyev R.R., Ortikaliyev B.S. Installation and operation of machinery and equipment of the chemical and building materials industry. Fergana. 2021.-348 p.
2. Z. Salimov. Basic processes and devices of chemical technology. Textbook for students of higher educational institutions. T.1. Tashkent: Uzbekistan, 1994. 366 p.
3. Калинин Э.К. и др. Интенсификация теплообмена в каналах. /Калинин. - М.: Машиностроение, 1990, 206 с.,
4. Кафаров В.В. Методы кибернетики в химии и химической технологии. - М.: Химия, 1985. – 448 с.
5. Nurmuhamedov H.S., Nig‘madjonov S.K., Abdullaev A.S., Asqarova A.B., Rambergenov A.K., Karimov Q.G. Calculation and design of machines and devices of the oil and chemical industries (examples and problems) Tashkent-2008. 390 pages.

6. Nurmuhamedov H.S., Jumaniyozov M.J., Abdullaev A.S., Babaev Z.K., Karimov Q.F., Yulchiev R.A. Repair and installation of devices of the chemical and oil industries. Tashkent 2011.
7. Фарамазов С.А. Ремонт и монтаж оборудования химических и нефтеперерабатывающих заводов. – М.: Химия, 1988. – 304 с.
8. Ермаков В.И., Шеин В.С. Ремонт и монтаж химического оборудования. Л.Химия. 1981г.
9. Илюхин В.В., Тамбовсев И.М., Бурлев М.Я. Монтаж, наладка, диагностика, ремонт и сервис оборудования предприятий. – М.: ГИОРД, 2006. – 504 с.
10. Дроздов Н.Э. Эксплуатация, ремонт и испытание оборудования предприятий строителных материалов, изделий и конструкций. Москва, 1979.
11. Хурсанов, Б. Ж., & Алиматов, Б. А. (2020). Экстракционное извлечение редких металлов из отвалов ГОК. Universum: технические науки, (6-1 (75)), 42-45.
12. Хурсанов, Б. Ж., & Алиматов, Б. А. (2022). Исследование Взаимного Уноса Фаз В Барботажном Экстракторе С Увеличенным Временем Контакта. Central asian journal of theoretical & applied sciences, 3(5), 28-33.
13. Дусматов, А. Д., Ахмедов, А. Ў., Абдуллаев, З. Ж., & Гапаров, К. Г. (2022). Междуслоевые сдвиги двухслойных комбинированных пластин и оболочек с учетом усадки композитных слоев. Oriental renaissance: Innovative, educational, natural and social sciences, 2(4), 133-141.
14. Xursanov, B., Latifjonov, A., & Abdulhakov, U. (2021). Application of innovative pedagogical technologies to improve the quality of education. Scientific progress, 2(7), 689-693.
15. Xursanov, B., & Abdullaev, N. (2021). Fundamentals of equipment of technological processes with optimal devices. Scientific progress, 2(7), 679-684.
16. Xursanov, b., & akbarov, o. (2021). Calculation of gas volume in the mixing zones of extended contact time barbota extractor. Scientific progress, 2(7), 685-688.
17. Алиматов, Б. А., Соколов, В. Н., Салимов, З. С., & Хурсанов, Б. Ж. (2003). Исследование распределения капель по размерам в многоступенчатом барботажном экстракторе. Журнал прикладной химии, 76(8), 1309-1311.
18. Karimov, I., Boykuzi, K., & Madaliyev, A. (2021). Volume-Surface Diameters of Drops in Barbotaj Extractor. International Journal of Innovative Analyses and Emerging Technology, 1(5), 94-99.
19. Xursanov, B. J., Mamarizayev, I. M. O., & Akbarov, O. D. O. (2021). Operation of mixing zones of barbotage extractor in stable hydrodynamic regime. Scientific progress, 2(8), 170-174.
20. Isomidinov, A., Boykuzi, K., & Khonnazarov, R. (2021). Effect of Rotor-Filter Device Operation Parameters on Cleaning Efficiency. International Journal of Innovative Analyses and Emerging Technology, 1(5), 100-105.
21. Isomidinov, A., Boykuzi, K., & Madaliyev, A. (2021). Study of Hydraulic Resistance and Cleaning Efficiency of Gas Cleaning Scrubber. International Journal of Innovative Analyses and Emerging Technology, 1(5), 106-110.

22. Алиматов, Б. А., & Хурсанов, Б. Ж. (1998). Расчет величины отстойной зоны барботажного экстрактора. Науч. техн. журн. Ферг. политехн. ин-та. Фергана, 1(2), 86-89.
23. Alimatov, B., & Khursanov, B. (2020). Analysis of droplets size distribution and interfacial surface during pneumatic mixing. Asian Journal of Multidimensional Research (AJMR), 9(6), 165-171.
24. Алиматов, Б. А., Соколов, В. Н., & Хурсанов, Б. Ж. (2001). Влияние газосодержания на производительность барботажного экстрактора по тяжелой жидкости. НТЖ ФерПИ, Scientific-technical journal (STJ FerPI), 2, 93-94.
25. Ахунбаев, А. А., Туйчиева, Ш. Ш., & Хурсанов, Б. Ж. (2020). Учёт диссипации энергии в процессе сушки дисперсных материалов. Universum: технические науки, (12-1 (81)), 35-39.
26. Дусматов, А. Д., Хурсанов, Б. Ж., Ахроров, А. А., & Сулаймонов, А. (2019). Исследование напряженно деформированное состаяние двухслойных пластин и оболочек с учетом поперечных сдвигов. In Энерго-ресурсосберегающие технологии и оборудование в дорожной и строительной отраслях (pp. 48-51).
27. Мирзахонов, Ю. У., Хурсанов, Б. Ж., Ахроров, А. А., & Сулаймонов, А. (2019). Применение параметров натяжного ролика при теоретическом изучении динамики транспортирующих лент. In Энерго-ресурсосберегающие технологии и оборудование в дорожной и строительной отраслях (pp. 134-138).
28. Алиматов, Б. А., Садуллаев, Х. М., Каримов, И. Т., & Хурсанов, Б. Ж. (2008). Методы расчета и конструирования жидкостных экстракторов с пневмоперемешиванием.
29. Khursanov, B. J. (2022). An Innovative Approach to the Design of Technical and Technological Processes of Production. Eurasian Research Bulletin, 11, 15-19.