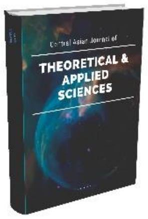

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Calculation of Performance Efficiency of Diffuser-Confuser Regenerate Apparatus

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Abstract: *According to a number of scientific and theoretical literatures, acceleration of the heat exchange processes in them is considered to be one of the main methods to increase the efficiency of various heat devices and equipment. In particular, the most alternative option for increasing the efficiency of regenerators with Yungström type plates is the use of diffuser-confuser type plates, which do not require a lot of investment.*

Keywords: *heat, diffuser - confusor, channels, hydrodynamics, Reynolds, plate rotor, regenerator, Jungström, resistance, heat exchange.*

Introduction

Scientific studies of heat exchange and hydrodynamic resistance in symmetrical diffuser-confuser channels of industrial heat exchange apparatuses were first studied by AA Gukhman and others.

As a result of the conducted experiments, according to the authors' conclusions, it was confirmed that the hydrodynamic resistance increases as the heat exchange in the channels of the symmetrical diffuser - confusor accelerates. In the course of research, an empirical equation for calculating heat transfer and hydrodynamic resistance was obtained.

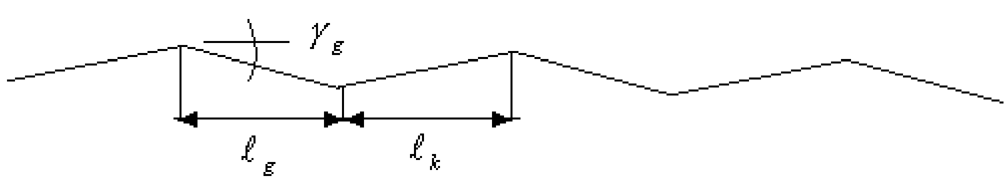


Fig. 1. Diffuser – confusor li surface

ℓ_g, ℓ_k *- diffuser and confusor of parts length ;* γ_g *- diffuser of part i opening angle.*

Scientific researches were carried out in channels of flat diffuser-confuser type, and diffusers expansion corner ($\alpha \leq 12°$), channel diffuser l_g Iconfusor l_k the ratio of the parts accordingly :

1. 5:1 ($l_g = 40$ *mm* , $l_k = 8.0$ *mm*),
2. 2:1 ($l_g = 40$ *mm* , $l_k = 20$ *mm*),

3. 1:1 ($l_g = l_k = 40$ *mm*),
4. 1:2 ($l_g = 40$ *mm* , $l_k = 8.0$ *mm*),
5. 1:3 ($l_g = 40$ *mm*, $l_k = 120$ *mm*) . received _

Conducted experiments Based on the resulting values, the following were determined:

$$\mathrm{Re} = \frac{U \cdot d э}{\nu};$$

$$\xi = \frac{\Delta P}{\frac{1}{2}\rho U^2} \cdot \frac{d э}{l}; \qquad (1)$$

$$Nu = \frac{\alpha d э}{\lambda}$$

where d is $_e$ - of the diffuser access diameter of the section

The results on heat transfer in channels with sharp and rounded edges are approximated by the following relation:

$$Nu = A\,Re^{\,n} \qquad (2)$$

here it changes in the range of 0.68 ~ 0.81 according to the ratio n – l_g/l_k .

According to the authors, a high rate of heat exchange is observed at a large length of the diffuser part (l_g/l_k =5:1) for all kinds of pre-wall flows, and the highest rate corresponds to the continuous flow.

All the mentioned results were considered with respect to the constant cross-sectional surface along the length of the straight channel.

In experiments on hydrodynamic resistance, a sharp change in resistance pressure and ξcomplexity = (Re) was observed. ξAccording to the authors, there is a diffuser flow in the channel with a longer diffuser section, and pressure losses are determined by the quadratic law. The influence of the Reynolds number on the coefficient of hydrodynamic resistance as the diffuser part becomes smaller is emphasized.

The coefficient of hydrodynamic resistance of channels with rounded banks is greater than that of channels with pointed banks.

In general, a rectilinear duct with a constant cross-sectional area along its length ξwill have a higher cost than diffuser-confuse type ducts.

Experimental values for resistance are approximated by the following relation:

$$\xi = B \cdot R_e^{-m} \qquad (3)$$

Jungstrom In order to use diffuser-confusor plates in the regenerator , it is necessary to change the design of the regenerator drum.

Fig. 2. Existing construction of the regenerator drum

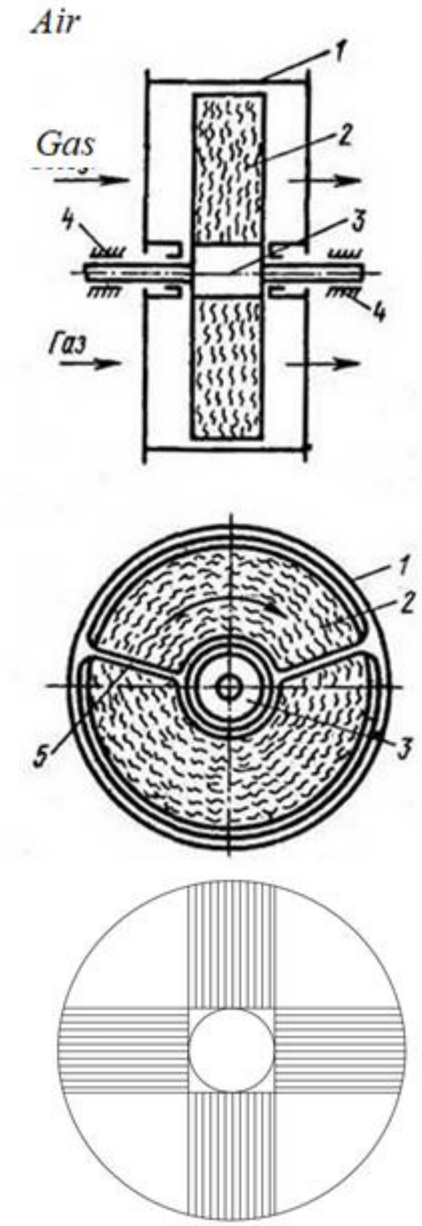


Fig. 3. Recommended construction of the regenerator drum

The methodology given in the first chapter can be used to calculate the efficiency of a rotor with a diffuser-confuser type channel. According to this methodology, the dimensions and weight of the heat exchange surface can be reduced due to heat acceleration.

The heat transfer equation can be written in the following form:

1. For a flat plate rotor:

$$Q = \propto \cdot F \cdot \Delta t \qquad (4)$$

2. For a rotor with a diffuser-confuser plate:

$$Q_{d-k} = \propto_{d-k} \cdot F_{d-k} \cdot \Delta t_{d-k} \qquad (5)$$

Assuming that the heat flows are equal for the options being compared, we get the following:

$$Q = \propto \cdot F \cdot \Delta t = Q_{d-k} = \propto_{d-k} \cdot F_{d-k} \cdot \Delta t_{d-k} \qquad (6)$$

From the last equation we get:

$$\frac{F_{d-k}}{F} = (\propto \cdot \Delta t)/(\propto_{d-k} \cdot \Delta t_{d-k}) \qquad (7)$$

It is observed that the surface of the rotor decreases proportionally to the increase of the heat transfer coefficient for the condition of temperature and pressure.

We reduce the heat exchange area for the following Reynolds numbers:

Diffuser - for a channel with a diffuser :

Table 1

Re	$1.5 \cdot 10^3$	$2 \cdot 10^3$	$2.5 \cdot 10^3$	$3 \cdot 10^3$	$3.5 \cdot 10^3$	$4 \cdot 10^3$
a	3.59	4.43	5.3	6.1	7.0	7.7
α_{d-k}	6.27	7.81	9.3	10.63	12.0	13,23

Diffuser - for a channel with a diffuser :

Table 2

Re	$1.5 \cdot 10^3$	$2 \cdot 10^3$	$2.5 \cdot 10^3$	$3 \cdot 10^3$	$3.5 \cdot 10^3$	$4 \cdot 10^3$
a	3.59	4.43	5.3	6.1	7.0	7.7
α_{d-k}	9.1	11.2	13,24	15.1	17.0	18.7

A diffuser is a confusor channel for :

Table 3

Re	$1.5 \cdot 10^3$	$2 \cdot 10^3$	$2.5 \cdot 10^3$	$3 \cdot 10^3$	$3.5 \cdot 10^3$	$4 \cdot 10^3$
a	3.59	4.43	5.3	6.1	7.0	7.7
α_{d-k}	10.5	13.0	15.2	17.32	19.4	21.4

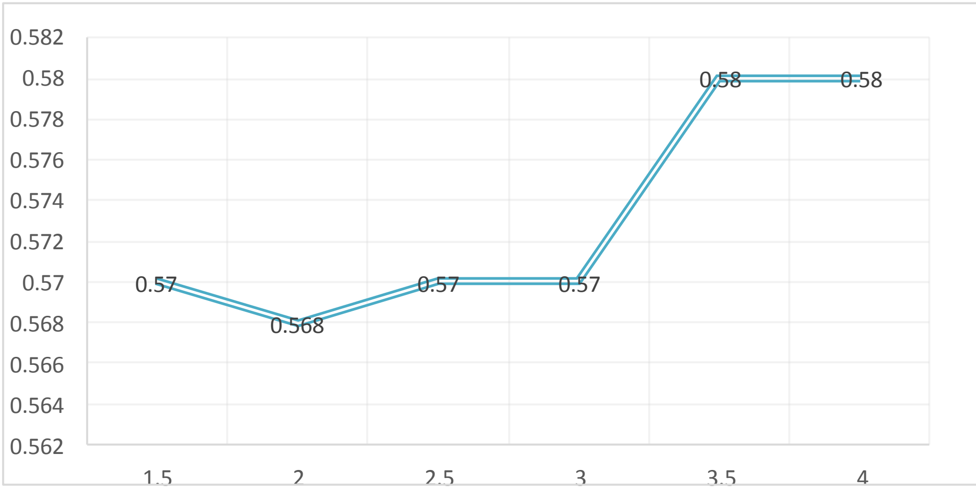
Saving due to the reduction of the heat exchange surface

D diffuser - for a channel with a diffuser :

Table 4

Re	$1.5 \cdot 10^3$	$2 \cdot 10^3$	$2.5 \cdot 10^3$	$3 \cdot 10^3$	$3.5 \cdot 10^3$	$4 \cdot 10^3$
F_{d-k}/F_{sil}	0.57	0.568	0.57	0.57	0.58	0.58

F_{d-k}/F_{sil}

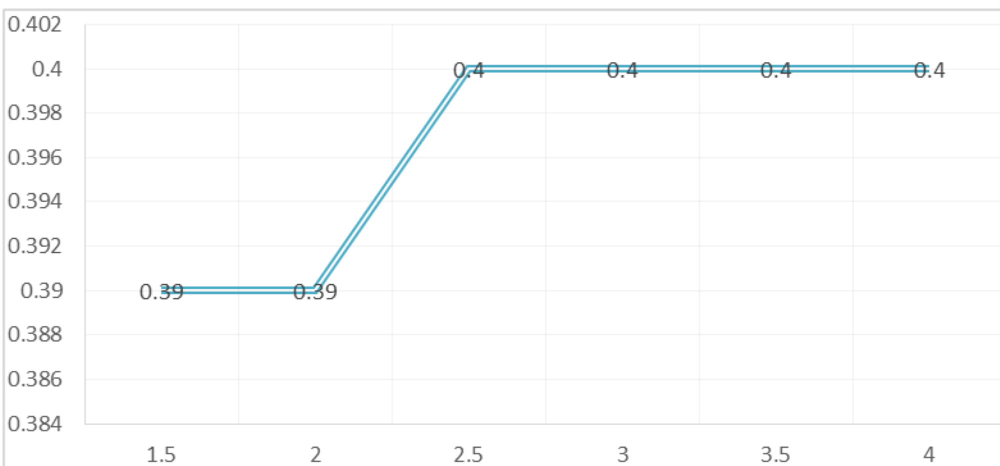


D diffuser - for a channel with a diffuser :

Table 5

Re	$1.5\cdot10^{3}$	$2\cdot10^{3}$	$2.5\cdot10^{3}$	$3\cdot10^{3}$	$3.5\cdot10^{3}$	$4\cdot10^{3}$
F_{d-k}/F_{sil}	0.39	0.39	0.4	0.4	0.4	0.4

F_{d-k}/F_{sil}

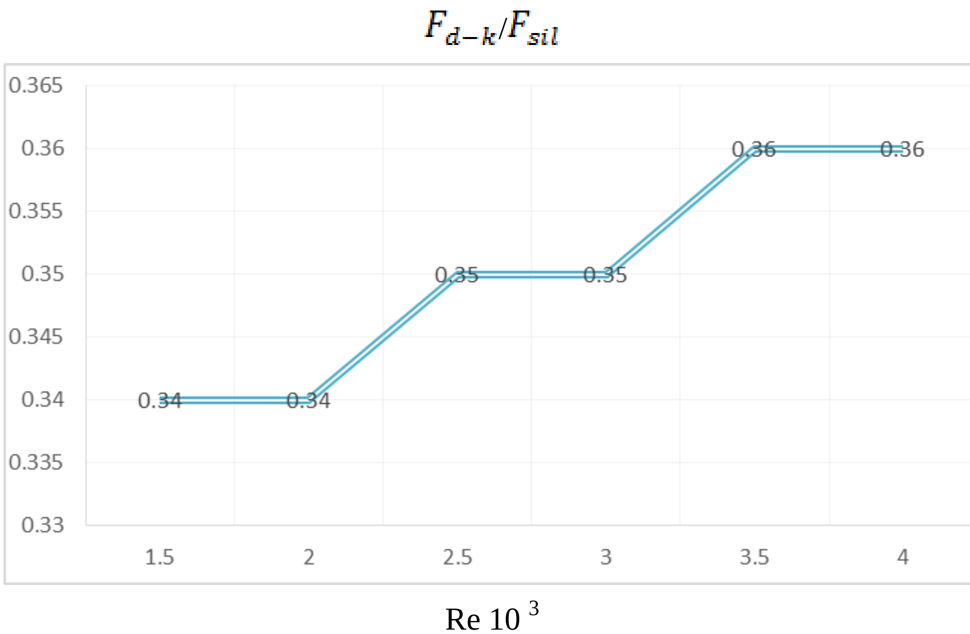


Re10 ^{3}

Diffuser - for a channel with a diffuser :

Table 6

Re	$1.5\cdot10^{3}$	$2\cdot10^{3}$	$2.5\cdot10^{3}$	$3\cdot10^{3}$	$3.5\cdot10^{3}$	$4\cdot10^{3}$
F_{d-k}/F_{sil}	0.34	0.34	0.35	0.35	0.36	0.36



Conclusion

To increase the efficiency of various heat devices and equipment, acceleration of heat exchange processes in them is considered to be one of the main methods. It has been confirmed that the hydrodynamic resistance of industrial heat exchangers increases as the heat exchange in the symmetric diffuser-confuser channels accelerates. In the channel with a longer diffuser part, there is a diffuser flow, and the pressure loss is determined according to the quadratic law. The flat and diffuser-confuser plates used in the metal nozzle of the Jungstrom regenerator are used for convective heat both by the air flow and by the gas flow. allows to increase the coefficients of giving.

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