A CORRELATION BETWEEN HEAT TRANSFER AND PRESSURE DROP IN HEAT EXCHANGERS OF DIFFERENT SHAPES

Summary:

The correlation proposed seems to be valid within an accuracy of ± 20%, and includes heat exchangers of very different forms. It also has many possibilities of application in other problems of heat transfer, like convection in furnaces, reciprocating engine cylinders, tube entrance effects, etc.

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NOMENCLATURE:

a_o	$[-]$	Correction coefficient for exchangers with finite number of rows.
A	$[m^2]$	Heating surface in one hollow of the exchangers.
c_p	$[J.kg^{-1}.K^{-1}]$	Specific heat at constant pressure.
D	$[kg.s^{-1}]$	Mass flow rate.
f	$[-]$	Friction factor, defined by Eq. (1)
$G_{máx}$	$[kg.s^{-1}.m^{-2}]$	Mass velocity referred to the minimum cross section
h	$[J.m^{-2}.s^{-1}.K^{-1}]$	Heat transfer coefficient.
L	$[m]$	Flow lenght in one step of the exchanger.
P_r	$[-]$	Prandtl Number.
R_e	$[-]$	Reynolds Number.
S_{min}	$[m^2]$	Minimum flow cross section (Fig. 4.2).
v_m	$[m^3.kg^{-1}]$	Specific volume of the fluid.
p	$[N.m^{-2}]$	Pressure drop in one step of the exchanger
f	$[kg.m^{-1}.s^{-1}]$	Dynamic viscosity at mean film temperature.
$m = 1/v_m$	$[kg.m^{-2}]$	Fluid density.

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1.- SUBJECT:

Heat exchangers theory is a very well known matter, specially on the so called compact heat exchangers (5.2.1).

The origin of the present paper is the request of defining quantitatively heat transfer phenomena obtaining inside the cylinders of steam engines (Rankine expanders), a field of renovated interest today. Al effects attibuted to that cause have been measured up to 50% of the theoretical steam consumption.

Originally it was aimed at to apply formulae derived from those used in the I.C. engine field provided the required ammendements to count for different fluid properties. Soon it was realized the inadequacy of their semi-empirical approach, and this led to think about a rational theory integrating all types of reciprocating machines.

It is well known the existence of a relationship between friction and heat transfer, yet only for a few cases in quantitative form. The first step was, therefore, to ask if it were possible a generalized correlation valid for heat exchangers of widely varying geometries, including heavily roughened tubes. And it is shown here that such a correlation is possible to a reasonable degree of accuracy, this proposed as a subject in itself and independently of the original motivations spoken of above.

It is hoped to present, in future papers, the whole treatment leading to the answer of the problems originating the present development; and also throwing light on old and inconclusive questions pertaining not only to reciprocating steam engines but also IC's, compressors, etc.

The present work does not pretend fully to answer the matter; it is

only the result of the need of disposing of a tool allowing a first quantitative assessment on different questions not answered by a lenghty and aged literature enquire.