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Development of Performance Test Apparatus and Design Program of Liquid-Phase Plate Heat Exchanger

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Key Words: Plate Heat Exchanger(   ), Performance Test Apparatus(   ), Design Program(   ), Liquid-Phase(   )

Abstract

The performance test apparatus of liquid-phase plate heat exchanger was installed and the computer program for design was developed in this study. The detail temperature distribution of hot and cold fluids in each path of heat exchanger was calculated by numerical method and the correlation for the heat transfer coefficient was defined. The heat transfer coefficients were measured using the working fluids of water and glycerine to investigate the effect of fluid viscosity. The measured heat transfer coefficients were compared with the calculated values obtained from the computer program and it was shown that error of the calculated values was generally less than 5%.

i   :
o   :

A   :
Cp   :   1.
F   : F-factor
LMTD :
m   :
Q   :   ,
T   :   .
U   :   ,   ,
ΔT   :
                                10%

                                                        .

c   :
h   :   .

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*   ( )
                                ,

                                .

2.

2-1.

pass   5
                                    pass

,

end effect   ,
chart   .

,   DX-3, DX-22, DX-143
chart   .   DX-146

.

.

.   database   .

.   ,   ,
                                    database   .

$$m_h Cp_h (T_{hi} - T_{ho}) = UA (T_h - T_c)$$
$$m_c Cp_c (T_{co} - T_{ci}) = UA (T_h - T_c)$$

,   2-2.
                                                    1

.   .   1   , end
                                    plate effect   ,
.   , end plate effect
40   .   ,
.
                                                ,
pass   end plate effect
pass   1   .
.   5   .

                                                5   ,   80°C
.   20°C   program
,   .

.   ,
                                    program U_{avg} U_{cal}

. U_{avg}
            . U_{cal}
    .

$$Q = \dot{m}_h Cp_h (T_{hi} - T_{ho})$$
$$LMTD = \frac{(T_{hi} - T_{co}) - (T_{ho} - T_{ci})}{Ln((T_{hi} - T_{co})/(T_{ho} - T_{ci}))}$$
$$U_{cal} = Q/(LMTD \cdot A)$$

        U_{cal} U_{avg}
            .

    1   .   ,
        5   ,
    U_{avg} .

$$\Delta T = F \cdot LMTD$$

    F factor

                    .
            , F=1   .
                                    5
        ,   end plate effect
        5   F factor
1. 0   .
    Fig. 1   80℃
    20℃   5   ,
program U_{avg} U_{cal}
        .   ,
            0.0005   2.0 kg/s
        ,   ,
                    .
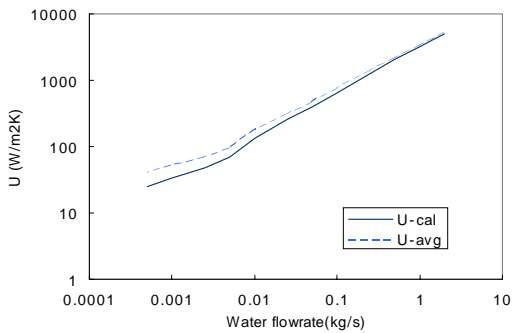
Fig. 1 Comparison of U_{cal} with U_{avg} when no. of path is 5

                ,   1 - 4%
            ,   ,
                12   34%
    .   ,   2
            4%   .
                            F-factor
                        .   F-factor
                    .

$$F = U_{cal} / U_{avg}$$

    DX-22H
        80℃   20℃   ,
0.1kg/s   ,
            U_{avg} U_{cal} F-factor
    Fig. 2   .
    Fig. 2   ,   1   F-factor
1.0   ,   2   0.87
                1.0
            .   ,
        ,   .

2-3
    D
                        .

$$Nu = C Re^X Pr^Y (\mu_b/\mu_w)^Z$$

        C, X, Z   , Pr   Y
Pr   .

                                ,
        U_{avg} .
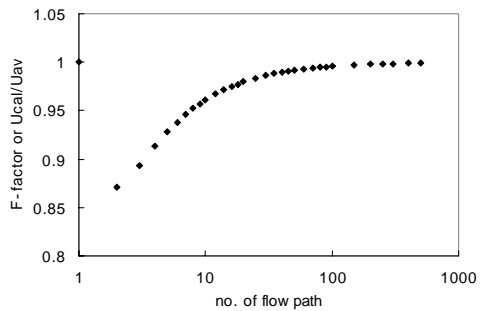
Fig. 2 Variation of F-factor

3.

3-1.

2003   9

. Fig. 3

.

D

DX-22

.

,   ,

,   ,

.

,

datalogger   PC

,   ,

.

6   10kW

,

.   20RT   ,

.

.

,

.

.
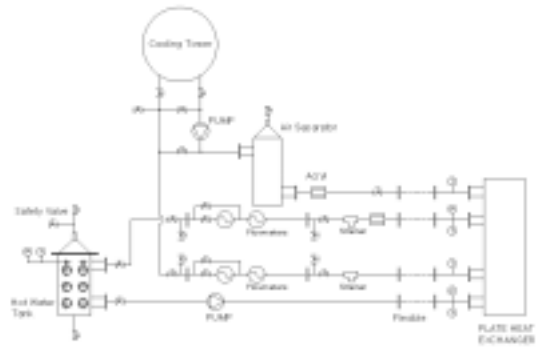
Fig. 3 Schematic of heat exchanger test apparatus

3-2.

.

,

.

,

,

,   .

.   ,

.

,

.   .

RID

.   ,

.

2200mm x 1500mm x 2200mm

.   1. 5   .

kW   4   datalogger   ,   PC

.   .   PC

,

,   .

,   ,

.   100%   datalogger

,   4

3   RID   .

5   RID   ,

.   RID 4-wire type ,   ,

3.2mm .   ,

.

3·3.   -

D   DX-22H

            11   ,

        .   ,

            10 ℃   .

                                Re

C*Re^x   .

$$C \cdot Re^X = Nu/(Pr^Y (\mu_b/\mu_w)^Z)$$

    Fig. 4   Re   C*Re^x   Log-Log
Plot   .

3·4.   -

  DX-22H

      ,

                    .

                        ,

98%

                    .

                    .

                            ,

                        .

                Pr

                    .   Pr

    (y)   Pr   .

                    .

                        .   Pr

            .

DX-22H   -

            Re   C*Re^x

        -                      C*Re^x

  Fig. 5   . Fig. 5

                            ,

                    .

Fig. 5

                                .

Table. 1   2   C*Re^x

                . Table. 1

, 2

        .   Pr

    ,

            .   ,   Pr

    Y   Pr   Pr

                        .

        Fig. 4   -   Fig. 5

        -

    ,

            ,   Re

                .
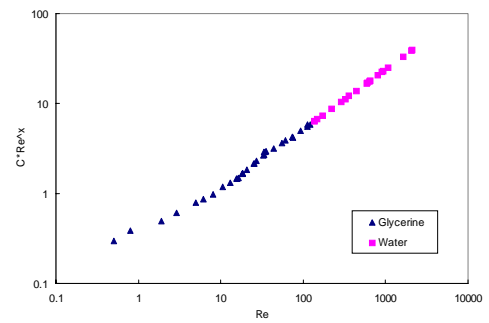
Fig. 5 Experimental results of DX-22H
glycerine-water heat exchanger

Table 1 Values and errors of C*Re^x

Re	water -water	glycerine -water	Error (%)
121.6	5.891	5.835	-0.9
112	5.604	5.841	+4.2
111.5	5.561	5.517	-0.8
93.7	4.952	4.988	+0.7

Fig. 4 Experimental results of DX-22H
water-water heat exchanger

4.

D

DX-3, DX-22H,
DX-22L, DX-143H, DX-143L   DX-146H   6

,   DX-22H   DX-143H   2

Fig. 6

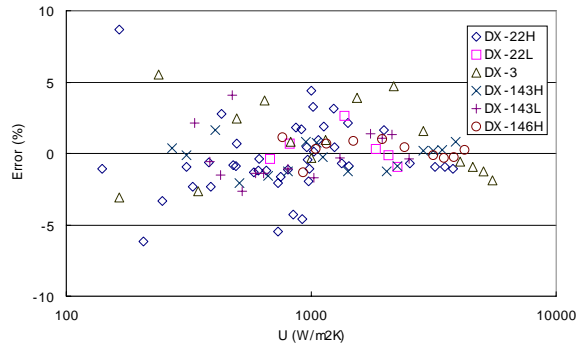Fig. 6 Error of calculation results using
design computer program

. Fig. 6   ,
5%

,   Re

5.

2%

.

5%   .

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