CFD Approach For Different Fluids Variants In Compact Heat Exchangers At Different Parametric Conditions.

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Abstract: Compact heat exchangers, because of their compactness, low weight and high effectiveness are widely used in aerospace and cryogenic applications. Here in this CFD approach is done for Compact heat exchanger with varying different fluids like MFC Coolant, Coolant ECSTAR, TFC anti-freeze. The approach is carried for with same parametric conditions for all the fluids to find the better fluid approach in getting temperature difference with CFD. The design is done in CATIA and the analysis is done in ANSYS. The paper mainly focused on the CFD approach with practical value comparison of blended coolants for heat transfer performance.

Keywords: CATIA, MFC Coolant, Coolant ECSTAR, TFC anti-freeze Coolant, Compact heat exchanger, ANSYS and CFD.

1. INTRODUCTION:
A heat exchanger is a device to transfer heat from a hot fluid to cold fluid across an impermeable wall. Fundamental of heat exchanger principle is heat flow from hot fluid to cold fluid. This heat flow is a direct function of the temperature difference between the two fluids, the area where heat is transferred, and the conductive/convective properties of the fluid and the flow state.

Compact heat exchangers Applications
Compact heat exchangers are very flexible in the various fields of possible applications. They are available with standard connections in various diameters and in different lengths. Compact heat exchangers can be designed in horizontal and vertical orientation and can be used for a wide variety of applications including, among other
- Compressed Gas / Water coolers
- Water / water coolers
- Oil / water coolers
- Preheaters, CIP-Preheaters
- Condensers and evaporators for chemical and technical processes of all kinds
- Machine coolers
- Oil coolers for hydraulic systems
- Oil and water coolers for power machines
- Refrigeration and air-conditioning units

PRACTICAL VALUES AND APPROACH
An approach has been made with present blended coolants with the help of local coolants to economize the cost variations in coolants. Distilled water blended with working fluids to verify the coolant reliability factors for blending and diluting. MFC Coolant, Coolant ECSTAR, TFC anti-freeze are the coolants and the working consideration with practical output check with the CFD values to validate coolant performance in the designed compact heat exchanger. Practical heat exchanger and fins designed followed the thickness of normal fins. Fin material- SS 316+ copper
Base plates- SS 304+ fly ash

DIMENSIONAL TABLE

<table>
<thead>
<tr>
<th>S. No</th>
<th>Dimension</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>600mm<em>400mm</em>25mm</td>
<td>Base plate-2 nos</td>
</tr>
<tr>
<td>2</td>
<td>1&quot; inch* 700mm</td>
<td>Tubes- 2 nos</td>
</tr>
<tr>
<td>3</td>
<td>0.5mm<em>50mm</em>800mm</td>
<td>Fins -10 nos bunch</td>
</tr>
<tr>
<td>4</td>
<td>1&quot; SCH 40</td>
<td>Nozzle- 4 nos</td>
</tr>
<tr>
<td>5</td>
<td>8 bar</td>
<td>Pressure</td>
</tr>
<tr>
<td>6</td>
<td>20°C- 200°C</td>
<td>Temperature zone</td>
</tr>
</tbody>
</table>

DESIGN APPROACH
Design has been carried out with CATIA R 20.0 version by taking the above parameters as design consideration. Fin shaped dimensions are given below
Sheet bend angle -15°
Sheet bend depth-10mm
Working module- surface
Heat exchanger- body
Pores medium- coolant types
Tube material ID- 25.4 mm
Tube material OD- ID+2mm

METHODOLOGY:

Coolant properties

<table>
<thead>
<tr>
<th>Coolant</th>
<th>Density Kg/m³</th>
<th>Thermal conductivity W/m°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFC Coolant</td>
<td>1120</td>
<td>6.231</td>
</tr>
<tr>
<td>ECSTAR</td>
<td>1065</td>
<td>5.163</td>
</tr>
<tr>
<td>TFC anti-freeze</td>
<td>861</td>
<td>5.231</td>
</tr>
</tbody>
</table>

The design is done such that the flow enhancement parameters of the fluids are to be taken in particular ratios of the desired parameters. The concentrations of these fin structures along the tube are even so that during the maintained velocity and pressure will be constant all along the system to obtain regular flow with span of time intervals taken for each fluid concentrations.

Properties of coolant blends
**CFD Approach:**
The characteristics of low-Reynolds flow and high-Reynolds flow are compared with contour plots of velocity with vectors. In the case of the case with inlet velocity of 0.3 m/s, the top velocity at the second tube is 0.88 m/s, nearly 3 times the inlet velocity. For the 6.2 m/s inlet flow case, the top velocity reaches 15 m/s, more than twice the inlet velocity.

**Meshed dimensions**

<table>
<thead>
<tr>
<th>Type</th>
<th>Fins</th>
<th>Base</th>
<th>Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of nodes</td>
<td>12700</td>
<td>12000</td>
<td>14000</td>
</tr>
<tr>
<td>No of elements</td>
<td>6350</td>
<td>5200</td>
<td>4500</td>
</tr>
</tbody>
</table>

**RESULTS:**
CFD has been carried out with the analysis software ANSYS 14.5 with meshing of single component as element, the approach with 3 coolants also stabilise with different inlet pressures and temperatures to get better analytical results.

**Analytical approach for water with MFC Coolant:**

Counter of static pressure at 60°C
Analytical approach for water with Coolant ECSTAR:

Counters of static temperature at 80°C

Counters of density at 60°C

Counters of static pressure at 60°C

Counters of velocity magnitude at 80°C
Counters of velocity stream line at 60°C

Counters of static temperature line at 60°C

Counters of velocity magnitude line at 60°C

Counters of density line at 80°C

Counters of static pressure at 80°C

Counters of velocity stream line at 80°C
Analytical approach for water with TFC Anti-freeze coolant:

- Counters of density line at 60°C
- Counters of static temperature line at 80°C
- Counters of static pressure at 60°C
- Counters of velocity magnitude line at 80°C
- Counters of velocity streamline at 60°C
Counters of static temperature at 60°C

Counters of static pressure 80°C

Counters of velocity magnitude 60°C

Counters of velocity stream line at 80°C

Counters of density 80°C
DISCUSSIONS
As per the approaches of CFD with different temperatures and pressure values the variation between practical approach and analytical variation is approximately 3 to 6%. Some practical losses cannot be ignored the variation of environmental problems will have considered as a primary difference in thermal component. The approach with composite material inputs given a difference the considerations are reachable as fair domain pores coolants in fluid aspects.

CONCLUSIONS:
The use of the CFD model offers particular benefits especially when minor modification is applied to the fin surface for which the correlation equations are not defined, for instance fin thickness modification. Here in these cases of CFD approach it is found that the TFC anti-freeze Coolant is having higher heat transfer rate than the other two fluids by which we can say that the TFC anti-freeze Coolant would be the better one in choosing the flow conditions temperature setup run in the case of CFD approach too.

REFERENCES:


