PREPARATION OF CORRUGATED TUBES FOR HIGH EFFICIENCY HEAT EXCHANGERS BY EXPLOSIVE TUBE FORMING

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1. Introduction

Large quantity of hot flue gases is generated from kilns, ovens and furnaces. If some of this waste heat could be recovered, a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered by heat exchangers (or recuperators) and the loss will be reduced.

A heat exchanger is an equipment built for efficient heat transfer from one medium to another. Generally, the two media are separated by a solid metallic wall, so that they never mix. These tubular heat exchangers are widely used in power plants, chemical plants, metal processing plants.

Main requirement for the heat exchanger tubes is that the heat transfer between the media inside the tube and outside the tube should be the maximum. That can be achieved in many ways. The most frequently used solution is the modification of the tube's construction as creation of enhanced surface or applying spiral strips for causing turbulences in the streaming media.

2. Experimental

An innovative solution is enhancing the efficiency of the heat exchanger tubes by creating spiral deformations on the tubes. The advantages of the properly designed deformation of the tube material are twofold: on one hand the heat transferring surface of the tubes will be enlarged and on the other hand the deformations will cause turbulences in the streaming media, enhancing the heat transfer.

The plastic deformation of the tubes are carried out by high pressure shock waves created by explosion of detonating cords positioned on the outer surface of the tubes.

Using the shock waves as tools acting on inner or outer surface of metallic tubes, shaped parts can be manufactured. The shock waves forming the metal tubes are created by chemical explosives. A chemical explosive is a compound or a mixture of compounds which, when subjected to heat, impact, friction, or shock, undergoes very rapid, self-propagating, heat- producing decomposition. This decomposition produces gases that exert tremendous pressures as they expand at the high temperature of the reaction. The work done by an explosive depends primarily on the amount of heat given off during the explosion. The high explosives can be utilized for many metalworking techniques.

The optimal form of the tubes has been designed by thermo-hydraulic computer simulation based on the ANSYS system.

Fig.1 Heat exchanger built with explosively formed tubes

Fig.2. Heat exchanger built with plain tubes

3. Results and conclusions

- Corrugation of the heat exchanger tubes creates extra turbulences resulting in enhancement of the heat transfer through the tube walls
- The heat transfer of the corrugated tubes are 8-15 % higher compared to the plain tubes
- The enhanced heat transfer gives the following advantages:
  - ✓ the heat transfer area (the geometry of the heat exhanger) can be reduced
  - ✓ a part of waste heat of the flue gases could be recovered so a considerable amount of primary fuel could be saved
- Corrugation can be carried out by shock waves acting on either the inner or outer surface of the tubes
- For industrial application more practical is the deformation of the tubes by shock waves acting on the outer suface of the tubes

4. References

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