PINCH

In its classic definition Pinch Technology " utilises thermodynamic principles and cost accounting to optimise energy use whilst taking into consideration such constraints as practical engineering and plant operability". In practice it is an effective way of avoid the pinch of energy costs on profits.

The relevant techniques have been developed during the past ten years or so, but process indutries have been slow to appreciate the potential benefits of using such techniques.

The British-led development of Pinch Technology provides a more systematic approach to a design task which, because of the complexity of many industrial processes, has often been pursued by trial and error. This was developed by teams led by prof. B. Linnhoff UMIST used in process integration studies it enables the designer to establish with confidence :

- the minimum energy needed to run the process,
- the process and plant design which cost least,
- the best investment strategy.

The advantages of the approach can most easily be seen in the example of a simple food plant. This may be considered rather mundane but does illustrate the principles involved, and the full power of the technique is demonstrated in the actual case study reports which follow.

Basic packaging line

In the packaging line, shown as a block diagram below, ingredients are heated, cooked and placed into containers that have previously been washed and pre-heated. The product is concentrated during the cooking process by evaporation and part is lost during filling. The filled contrainers are then sealed and cooled.

This means there are four process materials with distinct thermal properties — ingredients, product, empty and filled containers. And there are two site utilities — steam and cooling water.

The starting point

In the scheme shown in the diagram, there are obvious opportunities for heat recovery, and most plants operated to-day would have provision for it. These may, or may mot, provide the best possible arrangement. The starting point of any process integration study is the bare plant, stripped of any energy conservation measures.

Plotting the streams

For the purpose of analysis, the process is broken down into " streams " which are defined as parts of the process in which heat is added to or removed from a process material of constant mass flow. A ' hot ' stream is one which requires cooling to reach its final temperature. A ' cold ' stream requires heating. Thus, in our example streams 2, 3, 5 and 6 are labelled ' hot '; 1 and 4 are ' cold '.

Avoiding confusion

The first stage in the Pinch Technology approach to improving those figures is to be present the data in a way that avoids the confusion possible as plant complexity increases. This will often result in errors of interpretation with the probability that the optimum design will be overlooked.

The pinch technology way round this problem is described step by step in very informative appendices to the EEO R & D reports listed.

It is to simplify the data by combining all the ' hot ' streams into one composite; and all the 'cold' streams into another.

Elegant technology

The elegance of pinch technology becomes apparent when the composite streams are plotted graphically and the heating and cooling curves are represented on one diagram.

The horizontal placement of the curves is arbitrary, and as the two curves can be moved relative to each other along the horizontal axis.

Interest centres on the possibilities of heat transfer from hot streams (requiring cooling) to cold streams (requiring heating). It is therefore sensible to shift the curves until they overlap as much as possible.

In principle at least, heat can be transferred provided that the donor material is at a higher temperature than the recipient. Thus, wherever the graph indicates this state exists a transfer is possible, and in this region there is no need for heating or cooling from an outside source.

Conversely, where there is no such horizontal overlap between the curves, an outside source of heating or cooling is necessary.

The 'pinch point'

It now becomes a comparatively simple matter to identify the conditions in which the minimum heating and cooling are needed to maintain the process. This is achieved when the gap (the temperature difference) between the hot and cold composite curves is as small as possible.

A limit is imposed by the need to maintain sufficient temperature difference between the two streams to effect heat transfer.

This occurs at point of closest approach, which is called the 'pinch point' or 'pinch', and the temperature at this point is the 'pinch temperature'. (See composite graph below.) The pinch can, in fact, occur at the beginning or end of the curve as well as at the 'knee' as seen in this example.

The process energy flow is quantified by logging the starting and finishing temperatures of the stream (these are shown on the diagram) and the heat capacity flow rate of the stream. This represents the amount of heat needed to raise the stream temperature by one degree.

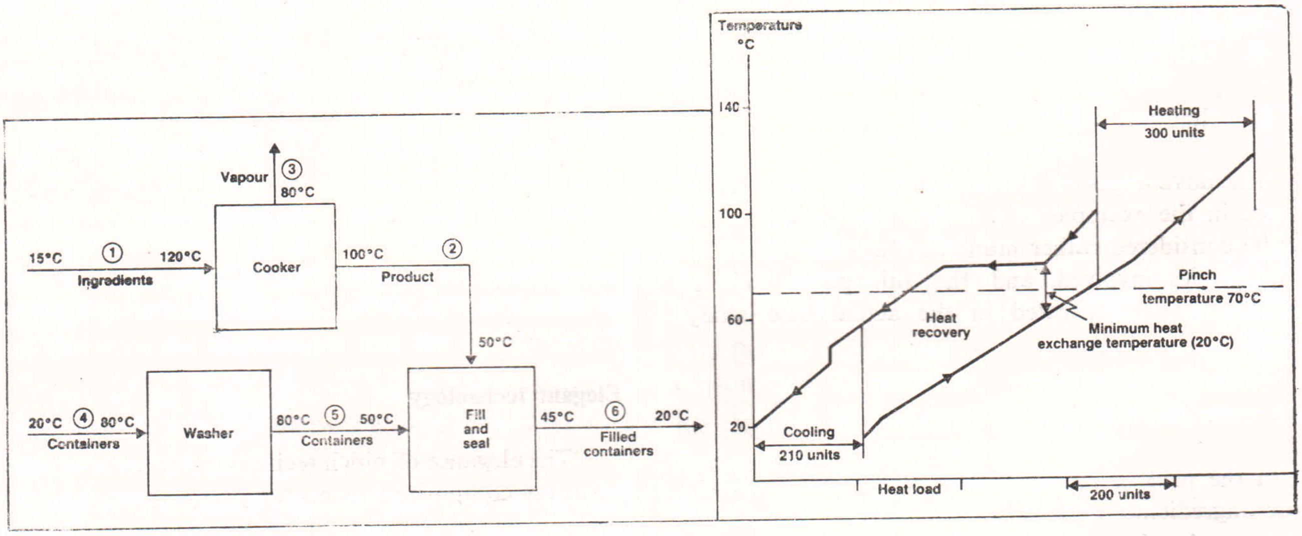
This data show that in the example operating the processes with no heat recovery would require the supply of :

- steam to heat 'cold' streams — 750 units.
- water to cool 'hot' streams — 660 units.

In the example here, it will be seen that the minimum heat exchange temperature is set at 20° C. giving minimum heating and cooling needs of :—

- steam heating — 300 units
- water cooling — 210 units.

The differences between these and the figures when there is no heat recovery indicates the scope for energy consumption.



The economic optimum

Where heat transfer takes place, the amount of external heating and cooling is minimised if the temperature difference is small, but then it is necessary to use large heat exchangers and the cost of the installation rises. On the other hand, a large temperature difference allows the use of smaller and cheaper heat exchangers, but more heating and cooling is needed to run the plant.

Clearly there is an economic optimum and, in most types of process plant, there is a recognised typical minimum temperature difference for heat transfer that still gives an acceptable heat exchanger design.

Don't pay twice

The fact that it is 450 units in each case highlights the link between heating and cooling. Using more heating than the minimum increases the cooling load by an equivalent amount. The operator pays for the mistake twice, in buying extra fuel and in supplying extra cooling.

In very simple cases with only two or three process streams, the minimum energy target could be established by conventional methods. Pinch technology enables complex plant to be analysed with only a little more effort than that needed in this example.

INDUSTRIAL ENERGY AUDIT

The training course on Industrial Energy Auditing conducted by SLEMA recently. This is the first time that a full fledged training course on Energy Auditing for engineers has been developed, organised and conducted by local personnel.

The training course was sponsored by the Ministry of Power and Energy and assistance by way of funding was received from the Energy Conservation Fund, the Ceylon Petroleum Corporation and the Ceylon Electricity Board. Special assistance was provided by the Netherlands-Sri Lanka Energy Programme.

32 participants drawn from the public and the private sectors, participated in the course which ran for a period of two weeks commencing from 14th July 1987.

Practical energy audit exercise was carried out at the Ceremics Corporation factory at Piliyandala, provided the necessary facilities and also hosted the participants and the lecturers during the 4 days' of practical work.

The course was inaugurated by Prof. K. K. Y. W. Perera, Secretary Ministry of Power and Energy.

A HISTORIC ANNUAL GENERAL MEETING

This year the annual dinner held at Galadri Meridian witnessed the ceremonial Award of Certificates to the participants of the Training Course on Industrial Energy Auditing conducted by SLEMA.

Members who participated at the annual dinner had the unique opportunity of being present at the first public declaration by a Minister of the government on the historical Indo-Sri Lanka pact. This first annoucement was made by the Hon. Gamini Dissanayake, Patron of SLEMA who was the Chief Guest on this occasion.

Nor, does it benefit stop at finding the target figure. By using the relevant data to produce what is known as the " Grand composite curve " a skilled practitioner in pinch technology can identify :

- beneficial process changes :
- the most appropriate site utility systems :
- opportunities for CHP schemes or heat pumps :
- changes to the plant-operating regime which will reduce energy costs.

Most important, published EEO report's clearly show that pinch technology works in practice.

Acknowledgement — Energy Management.

SOLAR HOT WATER SYSTEM WITH SPECTRALLY SELECTIVE SURFACE

An Australian firm, Somer Solar Pty. Ltd. claims to be the world's only solar heating manufacturer using a nickel black spectrally selective absorption surface.

Spectrally selective surfaces including the nickel black were developed by Australia's Commnowealth Scientific and Industrial Research Organisation (CSIRO) for use with materials such as copper, steel and aluminium.

Somar Solar refined the process for use on a continuous coating production line. The result is an absorption surface that is not only more effective than the usual black painted surface but also cheaper to produce.

Designed as a constant pressure tank, it is supplied with feed tank, safety tray, low profile solar connections, stove connections and off-peak electric booster element. The element is thermostatically controlled, to ensure plenty of hot water during periods of inclement weather.

The system can be customised to suit flat or sloping roofs ranging from 2 sq.m. to 500 sq.m. in collection area, with storage tanks ranging from tens to thousands of litres.