In looking at the costs of owning and operating an industrial pump, it is now widely accepted that every aspect must be observed. The true cost evaluation should take account of all elements, from purchase to scrapping – what is now defined as Life Cycle Costs (LCC).

Fig. 1 is a definition of LCC using guidelines established by the VDMA (association of German engineering shops).

In calculating LCC through time, account should be taken of the service life of the pump in years and allow for interest rate and inflation to arrive at the real interest rate. The formula also gives the ‘present value’ of each cost element (Fig. 2).

Factor examples and values for real interest (taking account of inflation) are worked out in Figs. 3 and 4.

Common elements and exclusions

LCC can be a valuable tool in purchase decisions and budget forecasting

The concept is also useful in comparing one type of pump with another. It is less useful for comparing pumps of the same type. For example, between two centrifugal pumps of similar capacity and material specifications, differences in LCC will be relatively minor.

When comparing the LCC of different types of pump, common values for factors such as inflation and interest rates must be assumed. Also some elements of LCC can be excluded as being dependent on individual circumstances. For example, downtime causing loss of production may be very high, but is very difficult to calculate in this context. Other elements, such as installation and commissioning, decommissioning and disposal and environmental costs, can be ignored for comparison purposes.

However, as this study confirmed, there can be significant differences between types of pump when comparing:

– Initial cost (which includes motor, base plate, couplings etc.)
– Energy cost.
– Routine maintenance cost.
– Repair cost.

Scope of investigation (fig. 5)

Five types of pump were investigated (3 sizes of each type, to match specified flow rates from 1m³/h to 8m³/h) and in each case LCC was calculated for operation at specific pressures from 5 to 100 bar. In practice, not all the pump types are suited for operation in all circumstances. Limiting factors include pressure, temperature, solid content, hazardous fluids and pump pulsation.

Investigative method

All data was provided by the pump manufacturer in each case. For each type of pump a prominent reputable manufacturer was chosen as representative. Each company was requested to select and price its most appropriate model to best meet given operating criteria, including flow, pressure and liquid specifications.

The same set of requirements was given to each pump company. Data was also requested on manufacturer’s recommendations for routine maintenance, costs of spare parts and labour for repairs, and the expected time between repairs. The required operational duty was 4,000 h/year, based on 50% of the 8,000 hours available in the year.

F.-W. Hennecke

A Comparative Study of Pump Life Cycle Costs

The theme of this article is an investigation undertaken in 2005 in which the comparative lifetime costs of four types of pump well known in the process industries and one which is less well known, but which in its field can be regarded as an interesting and viable alternative were examined. The pump types considered are: the centrifugal pump, the side-channel pump, the peristaltic pump, the membrane piston pump and the ‘Hydra-Cell’ pump. Each of these is generically different from other types of pump, and (with the exception of the Hydra-Cell, which is manufactured by Wanner) is produced by more than one company.
Fig. 6 shows operating data and pump data relating to one type of pump, the Hydra-Cell. Equivalent data was established for each type of pump over a hypothetical 10-year period. Zero values indicate that a particular element has been excluded for all pump types.

In Fig. 7, the data from Fig. 6 is used to calculate LCC for each of the 3 Hydra-Cell pumps working at 4 different pressure levels. The chart in Fig. 8 (Results 1) presents the results from Fig. 7 as a bar chart, with data grouped by pressure level. In Fig. 9 (Results 2) the same data is grouped by flow rate and presented as a chart.

Data from each of the five manufacturers was now set down to provide a basis for comparison between pump types. The figures in the Pump Comparison tables (1), (2), (3) and (4) relate to pumps in the small size/flow category working at low pressure.

Figs. 10–13 provide a detailed comparison of the pumps—starting...
with operational assumptions and covering cost, performance, main
tenance requirements and LCC.

■ The first comparison in Fig. 10 (Pump Comparison (1)) shows oper-
   ational assumptions, which are the same for each pump.

■ Fig. 11 (Comparison (2)) shows pump-to-pump differences in initial
cost, pump efficiency and energy costs.

■ Fig. 12 (Comparison (3)) reveals differences in maintenance, re-
   pair costs and expected frequency of repair for the five types of
   pump.

■ Fig. 13 (Comparison (4)) brings together these differences in the
   context of total LCC for each type of pump at a flow of 1.4m³/h and
   50m head (pressure of 5 bar).
All of these differences are expressed graphically in the bar chart in Fig. 14, (Comparison (5)). It shows that at low flows and low pressures the LCC for Hydra-Cell, centrifugal and side-channel pumps are similar. The peristaltic pump (lowest initial cost) has high repair costs. The membrane-piston pump, though energy efficient, has easily the highest initial cost and is expensive to repair. Parallel analysis was applied to values for larger sized pumps, representing the 5 types at higher flow rates. The bar chart in Fig. 15 (Comparison (6)) shows LCC for the pumps delivering 8.2m³/h, again operating at low pressure (5 bar). Centrifugal pumps showed the lowest LCC for these circumstances. For higher pressure applications (above 10 bar) only the Hydra-Cell and membrane piston pumps are taken into account, as the other types in our survey cannot usefully be considered for working at these pres-
The bar chart in Fig. 16 (Comparison 7) shows that the LCC for the Hydra-Cell pump is much lower than for the membrane-piston pump – its only real alternative at the higher pressure. The bar charts in Figs. 17–19 – LCC comparison surveys (1), (2) and (3), give a graphical summary of the results of the investigation into Life Cycle Costs. The results are arranged by size of pump.

Fig. 17 shows the results of Survey (1) which covers pumps capable of a flow rate of 1.4 m³/h.

Each survey chart relates the LCC of the pump to the five pressure levels at which it is operating. That is 5 bar, 10 bar, 50 bar, 75 bar and 100 bar. As previously noted, centrifugal, side-channel and peristaltic types have not been taken into account for operating at pressures above 10 bar.
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(100m head). From the survey, whose overall results are summarised in these three charts, certain conclusions can be drawn.

In terms of LCC, the Hydra-Cell, whose efficiency at high pressure is around 85%, is the most economic pump overall in the considered range, and it can pump abrasive, viscous, corrosive liquids and liquids with particles. The LCC of the side-channel pump is comparable, within its pressure range, but the pump can only handle clean fluids.

Centrifugal pumps are for low pressures and high flow rates. The LCC of the peristaltic pump is increased by its high consumption of replacement tubes. Membrane piston pumps are very efficient, but their investment cost and the costs of spare parts and labour when changing membranes are extremely high. The Life Cycle Cost of this type of pump can be up to 3 times higher than that of the Hydra-Cell.

LCC is of course not the only factor in a pump purchase decision. First there is the task the pump has to perform. The pump has to pump a fluid, which may have special characteristics, e.g. it could be corrosive, viscous or non-lubricating – and the pump will have to operate under specific conditions of flow rate, pressure and temperature. There may be other requirements, such as low pulsation and the ability to perform to standards of strict accuracy. The pump must also be reliable. If more than one type of pump can handle the task, LCC’s have to be compared. Short term, money might be saved by buying a cheap pump – but how long will it be before repair costs, energy consumption and possible production losses cancel out the original saving? This is why Life Cycle Costs are important.