

# Direct Fired Elution Heating – Avoid the Pitfalls to Gain Full Advantage

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Direct heating of elution liquor is proving to be a popular choice in gold production, particularly with small or short life operations. With correct handling, they will perform well and provide an adequate service life.

The following will provide some assistance and help operators to avoid some common pitfalls.

## WHAT IS DIRECT ELUTION HEATING?

Direct elution heating is the use of a directly fired vessel for heating of eluate strip solutions. This is commonly a modified water heater with a gas or oil burner.

This compares with other methods, where a fired heater heats thermal oil or glycol, which in turn is used to heat the eluate strip solution via a plate heat exchanger.

The main advantage of direct heating is the reduction in the amount of equipment required, eliminating a heat exchanger, pump and control loop.

The obvious downside of direct heating is the difficulty in controlling corrosion and scale formation within the heater, which we will discuss later.

## WHEN TO GO DIRECT HEATED?

Direct heating is probably best suited to small operations or short-life process plants.

The main problem with direct heating is the requirement to replace the shell of the heater on a regular basis. Depending on water quality, typical shell life can vary between 9 months and 3 years.

The replacement of shells (including necessary changeover downtime) should be factored into the cost estimation when looking at lifetime costing of the process. If the shells are large, or a number of replacements will be required over the mine life, it may be better to go to indirect heating.

## CORROSION AND SHELL MATERIALS – THE CHOICE IS NOT SO OBVIOUS.

The choice of an appropriate shell material for the heater is often not a simple choice. As the solution passes through the system once, there is no opportunity for water treatment. Although the solution is alkaline it is still corrosive, and is often prone to scale formation.

The temptation is to use stainless steel materials for construction. Although this may appear to be sensible, some problems arise (see below).

The relative cost of stainless steel construction is often more than double that of carbon steel construction. The author's experience has been that such construction rarely leads to double the service life for the equipment.

If good maintenance and operating practices are followed, an acceptable service life can be achieved using carbon steel construction.

### PROBLEMS WITH STAINLESS STEEL

#### - Stress Corrosion Cracking

Many elution liquors contain high levels of chlorides and sulphates. Even at levels of 200 ppm, the elevated temperatures can lead to stress corrosion cracking.

#### - Temperature Limitations

Many stainless steels do not exhibit good temperature / strength characteristics. The heat transfer surfaces may need to be constructed from increased thicknesses to cope with the surface temperatures, increasing construction cost.

#### - Passivation Limitations

Stainless steel relies on the formation of a good passive layer for its corrosion resistance. The nature of construction means that passivation of the internal weld surfaces is difficult and poor corrosion resistance results.

#### - Mixing Metals

One solution would appear to be the use of carbon steel for thick shell components, and stainless steel for increased corrosion resistance of the tubes. The weak point of this construction is the tube weld, where the stainless steel tube is welded to the carbon steel shell. Even utilising stainless steel filler material, this point becomes prone to corrosion at a higher rate than other areas.

## SCALE IN THE HEATER

Scale formation is a fact of life with direct fired heaters. Typical regions of heavy scale formation are the surface of the combustion chamber, front tube-sheet and upper tubes.

Scale formation causes three main problems.

- a) Increased corrosion rates due to underscale corrosion problems, and
- b) High metal temperatures in heavily scaled areas, potentially leading to metal deformation.
- c) Reduction in efficiency, increasing fuel usage and producing the temptation to over-fire the heater.

All of these may severely shorten the service life of the heater shell. It is important to control scale, and this should be part of a planned maintenance routine.

- 1) Select a suitable anti-scalent.  
The anti-scalent needs to be able to inhibit scale formation and resist decomposition at the heat transfer surface. Metal temperatures are higher in direct fired systems than in heat exchangers used in indirect fired systems.
- 2) Descale regularly.  
A chemical cleaning regime should be used regularly to remove scale from the heater. A rule of thumb is once every 5 strips, but this can be increased or decreased depending on water quality and rate of scale formation.
- 3) Use Inhibited Acid  
Acid descalents should include an acid inhibitor. The function of the inhibitor is to protect metal surfaces from acid corrosion once the scale has been removed. Cleaning with uninhibited acid may increase corrosion rates within the heater shell.

## DIRECT HEATERS ARE CLASSIFIED PLANT.

In many instances, direct elution heaters are classed as boilers, and must be designed and registered in accordance with AS 1228 in Australia (requirements may change in other countries).

If the outlet temperature of the eluate liquor is above the atmospheric boiling point of that fluid, then the vessel is classed as a boiler in Australian (whether the fluid actually boils or not). So if the strip temperature is above 100°C, then the heater will probably be a boiler.

If this is the case, you should make yourself aware of the design and plant registration requirements in your state or country.

In Australia, this will generally mean:

- 1) A requirement for design registration to AS 1228 with an appropriate body.
- 2) Plant registration with your governing body.
- 3) A requirement for regular inspections, with appropriate record keeping.

On large installations, specific operator training and certification may be required.

## IS DIRECT FIRED ELUTION HEATING RIGHT FOR ME?

In determining if direct fired elution heating is the correct choice, consider the following factors:

- 1) What is the expected plant operation life?
- 2) What is the water quality?
- 3) Can we control scale and corrosion to a reasonable level?
- 4) What is the expected number of shell changes, and what is the cost of this?
- 5) Can we meet plant registration requirements?

In many cases, direct fired elution heating will provide an economic method of strip solution heating. However, to obtain the full benefit of the capital cost saving, correct specification, operation and maintenance are required.

### About the Author.

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Jon is a qualified chemical engineer, with several years experience in the design, construction and maintenance of gold elution heating equipment.