RE-INVENT FURNACE PASS BALANCE CONTROL

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Re-invent furnace pass balance control

APC applications for balancing furnace passes were invented decades ago. Typically those schemes manipulate pass flows, aiming to equalize POTs (pass outlet temperatures). During the first few years of existence POT balancing was considered a valuable application though intelligent practitioners quickly realized they were barking up the wrong tree. The real constraint is PMT (pass metal temperature), whereas POT balancing is of limited value. The difference between PMT and POT is a function of furnace conditions as follows.

1. First and most important condition is the thickness of coke or fouling layer deposited inside the furnace tubes
2. Second, over-loaded firing chambers may exhibit flame impingement and hot spots
3. Third, PMTs thermocouple are welded onto furnace tubes. Weld imperfections may cause PMTs to read too high, creating a false alarm
4. Fourth, at best PMT measurement is representative of only a small section of the coil. There can be hot spots at other locations.

Why then POT balancing is not a very good idea? Should one of the furnace passes be fouled, that POT would drop below the other passes. POT balancing logic would then reduce the fouled pass flow, a completely incorrect action which increases the chance of coking in that pass.

Should we accept POT balancing on clean furnaces that experience neither coking nor flame impingement? Well, does anyone care about 10ºC POT differences if PMTs are not constrained? Actually I am inclined to go ahead and implement POT balancing on clean furnaces if that helps reduce operator load, but as far as real financial incentives go it is of marginal value.

What about dealing with coking and flame impingement issues? The main problem here is PMT measurement locations. Hot spots occur not necessarily where the thermocouple is located. To make such applications work we must support it by frequent visual inspection and/or pyrometer readings. Using those readings the operator can bias the POT readings to make them reflect a more realistic coil condition.

Further, the balancing logic is more complicated. Both PMT and POT must be taken into account. One might consider the following logic

- Instead of POT balance a pass representative temperature PRT
  PRT = A * POT + B * PMT + C
  A and B are weight coefficients judged by the APC engineer
  C is an operator coefficient used to indicate the difference between POT measurement and the hottest spot detected on that coil
- Permit the operator to overrule PRT logic by setting minimum and maximum pass flow % of the total. For example in a four pass heater, if one of the passes is known to be partially coked – the operator can limit that pass to carry no less than 25% of the total flow.

- Given that flow readings can be erroneous, permit the operator to also set minimum pass valve positions relative to the other pass valve positions. For example for that pass that is known to be partially coked – the operator can limit that valve opening to have that valve open 2% higher than any other pass valve.

Do we need MVPC (multivariable predictive controller) to implement such logic? Considering that PRT response to pass flow changes is fairly trivial, and that there is no need for a quick aggressive action, the MVPC does not offer much advantage over custom coded logic. I would leave it to the judgment of the APC engineer. Custom logic in this case is easy and inexpensive, but it may be more difficult to maintain.

To summarize out point of view, we have shown that POT balancing logic is not suitable for furnaces that experience coking or flame impingement, and proposed some logical modifications that would make such an application work more properly.