Name: **Mr. Pramod P. Kembhavi**
Address: 'Energy Solutions'
A6, Raunak Residency,
Mayur Colony , Kothrud ,
Pune – 411 038.

Measuring Equipment for Energy Auditors

At the outset , I would like to mention that accuracy and reliability of measuring instruments do occasionally change the broad based conclusions about efficiency or inefficiency of plant and equipment. While on the subject , I would like to share my experience with respect to steam flow meters and on line oxygen analysers.

(A) On Line Steam Flow meters :

During energy audit of steam system , on several occasions we try to establish the mass balance based on the set of on line steam flow meters existing in the plant.(There is no portable flow meter for steam flow measurement). Generally the set up is , steam flow meter installed on boiler outlet (one or more numbers depending on one or more steam outlet lines) and a set of flow meters at consumer ends .In 90 % of the cases , the generation and consumption balance does not match ! The escape route for the engineer in charge is to declare some of the flow meters as inaccurate and nonfunctional and allocate the mismatch to a certain equipment / section consumption , declaring it as inefficient. Meters are many a times selected based on cost , instead of accuracy and reliability. This leads to their ineffectiveness.

While there is no ready made remedy for the above , certain precautions & measures as mentioned below would enable more authentic assessment of flow measurement :

1. Maintain daily (& in some critical cases hourly) records of generation and consumption. This would give an idea about pattern of consumption / generation. Actual expected generation and consumption can be established by analytical means .e.g. for generation we can get idea based on fuel consumption (which in most of the cases is quite authentic since daily receipts , stock and consumption based on metering / dipstick etc. are generally maintained) and boiler efficiency by indirect method. As regards consumption , establishing actual heat load with practical efficiency factors on consumption side would give fairly accurate idea of expected flow.
2. Regular calibration of flow meters.
3. Verification based on condensate measurement (flash to be accounted appropriately)
4. Detecting obvious errors such as flow indication while there is absolutely no flow , and correcting the same through repair / replacement.
5. Ensuring right sizing and selection of flow meter based on actual % load variation. In many cases we have observed that incorrect meter sizing with respect to actual flow variation has led to false conclusions.
6. Ensuring proper installation of flow meter : Causes such as protruding gaskets for vortex flow meter may result in gross inaccuracy. Also , requirements of

straight lengths upstream down stream also should be inline with the supplier recommendations.

Certain type of flow meters , such as vortex type , tend to be more accurate and reliable compared to orifice type provided the sizing , pressure temperature conditions are within the permissible limits.

A detailed energy audit many a times helps to identify the weak link between generation and consumption.

(B) Water flow measurement : Installation of rotary vane type flow meters on water line is comparatively an economical solution (compared to steam flow metering) and the calibration check is easier (which can readily be conducted at site).As about accuracy of measurement , it is no better or worse than steam flow meters. Water temperature makes large difference with respect to life , accuracy and reliability. It has been observed that meters (rotary vane type) have failed frequently when water temperature exceeded beyond 90 degC. Regular check on the accuracy should be carried out by actually measuring the flow (which is easily possible at site) against the meter reading. Many a times these are used to verify flow from steam flow meters at boiler outlet (with meter installed on feed water line).While there is nothing wrong in this , due accounting of blow down etc. are of prime importance to arrive at conclusion. Generally accuracy of steam flow meter is expected to be higher than water flow meter.

Regarding portable ultrasonic water flow meters used for flow measurement , the accuracy and reliability is extremely suspect and depends on several factors such as pipe dia , surface preparation of pipe section , location of installation , pipe inside surface condition (scale formation etc.). Many a times it just proves as an eye wash for the customers. More practical approach of flow measurement is desirable.

(C) Air Flow Measurement : Rotary vane type anemometer and hot wire anemometer are most commonly used. The usefulness of both of these is limited to know air flow on a very gross basis , since these mainly indicate average velocity at point of measurement. If the flow area can be established accurately (which is very difficult in many cases) flow estimations are fairly accurate. If the flow area is large , larger inaccuracy creeps in. Measurement with pitot tube definitely gives better results though it is comparatively time consuming.

(D) Measurement of O2 / CO2 / CO in flue gas

- Portable Flue gas analyzer : Used for measuring O2 / CO2 and CO.

O2 measurement is generally taken as a base and CO2 is computed based on a formula (which takes in to account fuel characteristics).These analyzers use zirconium based oxygen cells which have limited shelf life. This many a times leads to failure of this instrument and the cell has to be replaced .Also , air leakage through connecting tubes , insufficient suction etc. lead to false results. These generally function OK with forced draft systems where you can expect slightly positive pressure at the point of measurement. However with induced draft system with ID fan , frequently false results have been observed due to limited suction capacity of motors in gas analyzer to suck the flue gases.

Also , dusty atmosphere such as husk , bagasse , pulverized coal etc. result in choking of suction filter and failure of instrument.

On line analyzer take care of most of these problems , however , these are costly and justify mostly in case of larger capacity boilers.

CO indication is useful to a certain extent to know the quality of combustion with respect to variation in excess air .Generally , unburnt combustible losses indicated by CO are insignificant .

For automation of combustion control , on line oxygen analyzer is best suited since it can give 4 – 20 amp signal which can be used for controlling damper or variable speed drive. However , criticality & frequency of load changes and the response time of modulating control needs to be studied before installation of auto control system. Generally , on line oxygen analyzers are reliable and the problems are mainly related to oxygen cell life and the quantity of particulate matters in flue gas. More problems are encountered with very high load of fly ash content in flue gas (such as for FBC coal fired boilers).

In general it is a good idea to use the above measuring instruments keeping in view their limitations and the accuracy needed. It has been observed in many cases , unless the accuracy of instruments is grossly erratic , they can lead us to reasonably good conclusions about equipment / system performance.

Pramod Kembhavi