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As rightly pointed out, the strength of the instruments available with an Audit firm definitely boost the confidence of the client on their work and the audit firm as well. But the real use and the results are depends on many field factors particularly for flow measurements like

1. Skill level of the instrument operators whatever may be the sophistication and accuracy of the instrument
2. The selection of the measuring points/locations
3. The accuracy levels of the input parameters like pipe diameter, pipe wall thickness, duct sizes, physical properties and temperature of the measuring fluids etc.
4. Accessibility and installation of the of the instrument to/at the measuring points etc
5. ***Last but not least most of the measurements (not all) made by auditors are not the first one. Auditor will be measuring a parameter which had been already measured and communicated to the senior technical/commercial persons and some major financial/technical decision already would have been taken. For example the industry will have a figure in mind and our readings should match their fig even if it is wrong! If not, Result will be the immediate blame on the instruments used by the auditor whatever the sophistication and accuracy the instrument. Beware the flow conditions may be manipulated without the knowledge of the auditor during measurements to get the values the industry wants to prevent any backfire from top management. Hence It is foremost important to get the full confidence of the client (industry) on the auditor's instruments before taking any measurement but it happens very rarely.***

### **Air flow Measurement**

We observed in our experience the best instrument for air flow measurement in filed is the simple U tube manometer (water/mercury) with a Twin tube pitot tube (Two separate Pitot tubes connected facing opposite sides of 10 mm dia each, used for dusty air and to measure differential pressure) . The error level is minimum compared to the any other digital/electronic instrument. It has good repeatability, reliability and requires non expensive maintenance. We had also used digital instruments of having accuracy +/- 1%, which has equal reliability and accuracy. It requires little expensive maintenance like battery and calibration charges etc. Once failed can not be repaired and new instrument has to be purchased. **Therefore a simple compact manometer (folding type with sufficient length and magnetic grip)with a pitot tube will be sufficient for measuring air flow in ducts and chimneys.**

On the other hand Vane type anemometers give good results for measuring open air velocities like in cooling tower fan, blowers suction side velocities. We observed these instruments are reliable and accuracy levels are also high. The best part is we can get steady and non fluctuating readings in this instrument. Final result is again depend on the accuracy of the average air velocity calculated and the dimensional measurement of the flow area. Calibration facility is also available at reasonable cost. No major failure

encountered since its purchase in the year 1995. *Therefore we prefer a simple vane type anemometer for measuring air flow in cooling towers and blowers with a range of 30m/s and +/- 1% accuracy.*

For measuring high pressure air/gas flow in case of compressed air/N.G, on line flow meters work better. Any online instruments having moving/rotating components kept on line for prolonged period bound to give inaccurate values and need regular calibration. We advice the industries to install the meter in a bypass line and use the instruments as and when required for measurement and most of the time it should be isolated from the main. (In case of metering like N.G/Producer gas etc we do not have any other option.) This helps to maintain the accuracy level and reduce maintenance cost. The worst part is the instruments are costly and any failure needs replacement with new one.

*This kind of instrument is not required for auditing purpose and we can apply indirect methods for assessing flow with reasonable accuracy.*

### **Water flow Measurement**

In our experience in water flow measurement we found that the non intrusive Ultra Sonic Transit Time Liquid flow meters are come handy with reasonable accuracy. The accuracy level depends on the factors mentioned above and above all the skill of the person using the instruments. We can measure the flow at any location in the piping network provided if it is accessible. Accuracy levels are affected by the inside/outside surface roughness, sensor location, turbulence etc. The other stored information like properties of pipe material, speed of sound etc. Nevertheless we can take measurement with an accuracy of 5-10% which can be used for any calculation. (In our case we have BIS approved pump testing laboratory to ensure the accuracy, we regularly compare the flow meter with V notch test bed). Needs less maintenance but the calibration is very costly. For a four point calibration it needs nearly 1.00 Lakh rupees and the facility is available only at Central Power Research Institute, Bangalore. The instrument is very suitable and effective on smooth pipes like PVC, new MS pipes, Asbestos and cement pipes for clear water/sea water. Regular charging of the battery is a must. In field conditions the old pipes can be replaced with new one if required. We have not faced any major failure in the instrument that needs repair since its purchase in the year 1998. *We therefore prefer to use this instrument for water flow measurements in pipes although the initial investment is high, needs about Rs.2-2.5 Lakh.*

### **Steam flow Meter**

As we know that measuring steam flow is very complicate in nature owing to its continuous change in the quality. As of now we measure the steam only by indirect method. Since the steam is used in most of the industry for process heating and at wet condition. We have not come across any flow meters for wet steam flow measurement. We observed in one chemical industry where the steam flow was measured using online meters and for their surprise it hardly worked for a month and failed. The investment made is about 5.0 Lakh. *As an auditor it is advisable to measure the steam flow indirectly instead of going for any steam flow measuring instruments.*

### **Flue Gas analysis(Measuring O<sub>2</sub>/CO<sub>2</sub>/CO/ S)**

There are gas sensors available for measuring O<sub>2</sub>/CO<sub>2</sub>/CO and for S. These sensors have self life period of maximum 2 years only. Therefore whether the instruments are used or not sensors have to be replaced for accurate measurement which require about Rs 8000-15000/- per sensor hence expensive. But the values are accurate provided the gas filter system is working fine. The second type is the fyrite less expensive and accurate. The readings can be taken with an accuracy of +/- 1%.. The life of the gas absorbent is long and needs less cost for replacement. These instruments are portable and come handy for the auditor. Field s

efficiency calculation can be made immediately. The problem with this instrument is leakage of the liquid absorbent, needs better corrosion resistant sealing.

The other type of instrument is the Stack monitoring Kit. This instrument is provided with temperature probe, Pitot tube for pressure measurement and glass jars for gas sampling along with an electric gas suction pump for drawing a predetermined gas through the gas absorbent. The gas sampling is done by absorbing the gas in the absorbent and tested in the laboratory. The major draw back is that no on site calculation can be made unless the samples are analyzed in the industry itself but it is the best and accurate method. We use this instrument if the gas is too dusty.

*In general we suggest fyrite for energy auditor for flue gas analysis which has less maintenance and recurring cost with reasonably accuracy. Initial investment is also less and it is easy to operate.*

In many of our digital instruments after two-three years of operation if any repair comes seek advice from the supplier, the answer we get is that, **“Sorry sir, we had stopped the manufacture of that old model and no spare parts are available and you can go for our new updated version!”**. Selecting an instrument with high accuracy which is equally sensitive will confuse the auditor and the client as well due to fluctuating readings at wider range as it is rare to get steady state operation in practice. **Therefore we strongly feel that less expensive fundamental instruments with a reasonable accuracy up to +/- 1% will be sufficient for Audit purpose.**

The other lacuna is the availability of calibration facility in one place. There is no laboratory as far our knowledge which can do the calibration for all energy audit instruments at one go. **BEE should consider establishing such laboratory in future at various locations in our country.**

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