MCERTS Bulletin 24

Flow measurement using the pump running hours methodology

The pump running hours methodology was prepared by EON Engineering as part of the Joint Environment Programme (JEP) funded work.

The methodology was offered as a potential solution for measuring large volumes of water in situations where it is not feasible to install a typical flowmeter as the construction costs would be excessive and/or there is no suitable flowmeters available.

The methodology was prepared during 2007 and discussed by the MCERTS Project Steering Committee in October 2008. This was considered to be an acceptable method of flow measurement in principle. However the MCERTS Project Steering Committee wished to review the results from test data.

Some testing was conducted during 2008 and the results circulated to the MCERTS Project Steering Committee for discussion in March 2009. A report discussing the tests conducted was prepared and submitted to the MCERTS steering committee for further discussion in October 2009.

Following the third review of the pump running hours methodology along with the report for the supporting test data, the MCERTS Project Steering Committee is now satisfied that the pump running hours methodology can be used as a method for measuring large volumes of water flow.

This methodology is only to be used following the recommendation of an MCERTS Inspector.

Use of this methodology is restricted to the power industry and only for the measurement of large flows where the installation of traditional flow measuring equipment is not feasible or incurs excessive costs.

PROCEDURE FOR MCERTS INSPECTION OF PUMP RUNNING HOURS METHODOLOGY

The pump running hours method relies on measuring the pump suction and discharge pressures to determine the head developed by the pump. A pump performance curve for pump head against flow is used to establish the flow.

An MCERTS inspection shall include:

1 Review the pump performance curve used to establish the flow

2 Check the pump nameplate to ensure that is corresponds to the pump curve being used

3 Measure the pump suction and discharge pipework diameters. NOTE internal bore is needed but measure the external bore and seek clarification for pipe wall thickness. (i.e. from site drawings, pipe schedules etc)

4 Inspect pressure transducer at pump suction
- Note manufacturer
- Note operating range
- View calibration certificate

5 Inspect pressure transducer at pump discharge
- Note manufacturer
- Note operating range
- View calibration certificate

6 Inspect temperature probe at pump suction
- Note manufacturer
- View calibration certificate

7 The data from the instruments should be displayed in the control room. It is envisaged that the suction temperature and pressure and the discharge pressure will be displayed along with the calculated flow. Collect data from the screens over a suitable period of time (say 10 minutes)

8 Calculate the head from the pump (refer to appendix A for the theory and Appendix B for the method)

9 Determine the flow

10 Compare the calculated flow values against the recorded flow values.

Appendix A : Calculation of Pump Head - Theory

A typical pump performance curve will provide the relationship between the Total head and the flow. Establishing the flow using the pump performance curve is based on measuring the pump suction and discharge pressure for the pump. These readings along with the dimensions of the pipework can be used to determine the Total Head delivered by the pump and from this the flow can be established.

The Total Head from a pump is derived from three components:

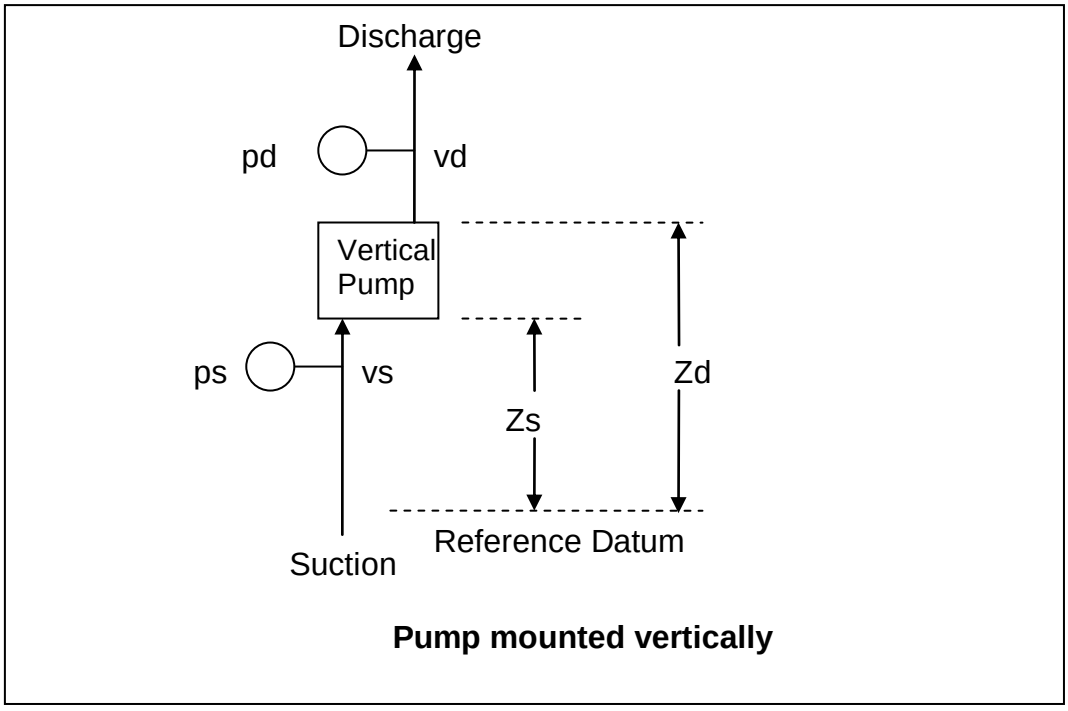
The Static Head. This is the difference in the relative height between the discharge and the suction pipes.

The Pressure Head. This is pressure difference of the pumped fluid between the discharge and the suction pipes.

The Velocity Head. This is the difference in velocity of the pumped fluid between the discharge and the suction pipes.

The relative height is the difference in height between the pump suction pipe and the pump discharge pipe.

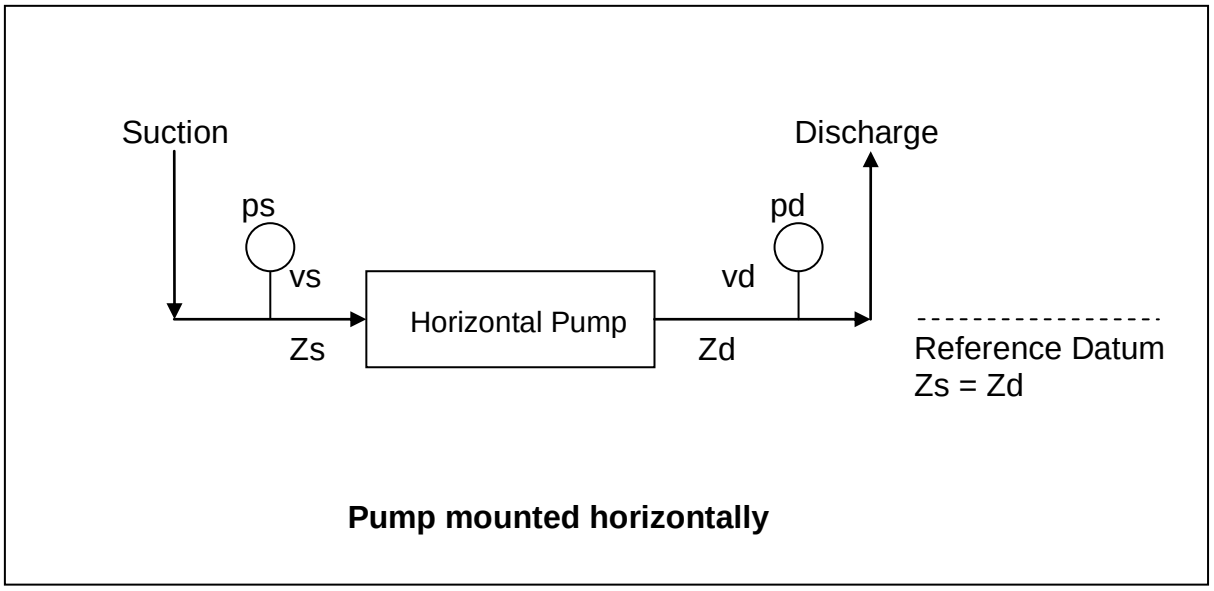
For a pump that is mounted horizontally the relative height will be zero as both the suction and discharge pipes are on the same plane. For a pump that is mounted vertically there will a difference and this should be taken from a reference datum. The diagrams below demonstrate the difference between vertically and horizontally mounted pumps:



Pump mounted vertically

Where:

Zs = relative height of the suction pipe from a fixed reference datum
Zd = relative height of the discharge pipe from a fixed reference datum
ps = suction pipe pressure
pd = discharge pipe pressure
vs = suction pipe velocity
vd = discharge pipe velocity



Pump mounted horizontally

The total head will be:

Static Head : $Zd - Zs$

Pressure head: $(pd - ps)/(\rho \times g)$

Velocity Head : $(vd^2 - vs^2)/2g$

Where:

g = acceleration due to gravity (9.80665 m/s^2)
ρ = density of fluid in kg/m^3

The three terms are combined to give the Total Head as:

$$H = (Zd - Zs) + [(pd - ps)/(\rho \times g)] + [(vd^2 - vs^2)/2g]$$

In order to determine the total head it will be necessary to establish the diameter of the suction and discharge pipes.

Appendix B : Calculation of Pump Head - method

The method used to determine the flow from the pump is provided in the calculation below.

FIXED DATA	
g	9.80665
PI	3.14159
suction diameter (mm)	Ds
suction area (m^2)	As = PI $(Ds)^2$ /4,000,000
discharge diameter (mm)	Dd
discharge area (m^2)	Ad = PI $(Dd)^2$ /4,000,000
suction reference height (m)	Zs
discharge reference height (m)	Zd

Parameter	Symbol	Unit	Notes
density	p	kg/m^3	At the suction temperature
Static Head	(Zd - Zs)	m	
Pressure Head	(Pd - Ps)/(p x g)	bar abs	
Flow based on Pressure Head	Fp	Litres/s	Establish the flow using the pump performance curve at the calculated pressure head
velocity head (suction)	Vs = Fp/(1000 x As)	m/s	Determine the velocity in the suction pipe
velocity head (discharge)	Vd = Fp/(1000 x Ad)	m/s	Determine the velocity in the discharge pipe
Velocity Head	$(vd^2 - vs^2)/2g$	M	Calculate the velocity head
Total Head	H	M	Summate the static, pressure and velocity heads
Flow based on Total Head		Litres/s	Establish the flow using the pump performance curve at the calculated total head