Kessler-Ellis Application Note F015

Calculating and Using K-Factors

1. What is a K-factor

Simply stated a K-factor is a dividing factor. The term is usually encountered when dealing with pulse signals although analog K-factors are sometimes used.

2. Pulse Signal K-factors

All pulse output type flow meters when they are dispatched by their manufacturer will have a calibration certificate. The calibration certificate will show that the meter has been calibrated over its flow range and noted on the certificate will be the average K-factor for the meter.

This K-factor will be given in terms of the number of pulses produced by the meter for a given volumetric flow. (e.g.) 200 pulses per U.S. gallon, 150 pulses per liter etc.

This K-factor is the value that is entered into a batch meter or indicator/totalizer in order to give a readout in engineering units.

Example 1

If the display on a rate meter is required in U.S. gallons per second, and the K-factor of the flow meter is 210 pulses per U.S. gallon, then the K-factor entered into the rate meter would be 210.

If a totalizer associated with the same flow meter was to be set up so as to totalize in U.S. gallons the totalizer K-factor would be 210.

If the totalizer was to be set to totalize in tenths of a gallon the K-factor would be 210/10 = 21

Example 2

If the display on a rate meter is required in U.S. gallons per minute, and the K-factor of the flow meter is 210 pulses per U.S. gallon, then the K-factor entered into the rate meter would be:
210/60 = 3.5

3. K-factors for Analog Input Signals

When batching, indication or totalization has to be carried out using an analog input signal a KEP product first converts the 4 to 20 mA signal into a 0 to 10000 Hz. signal. The K-factor is then calculated by relating the engineering unit equivalent of 20 mA to the 10000 Hz. signal.

Example 3

A vortex meter outputs 20 mA when the flow is 2000 U.S. gallons per minute, we wish to display the rate in gallons per minute.

The rate K-factor is = 10000/2000 = 5

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The value of the totalizer K-factor will depend on whether the flow rate was given in units per second, minute or hour and whether it is desired to totalize in whole units, tenths, hundredths etc.

If the flow rate was given in units per second the totalizer K-factor (for whole units) is obtained by multiplying the rate K-factor by 1.

If the flow rate was given in units per minute the totalizer K-factor (for whole units) is obtained by multiplying the rate K-factor by 60.

If the flow rate was given in units per hour the totalizer K-factor (for whole units) is obtained by multiplying the rate K-factor by 3600.

The totalizer K-factor in **example 3** will be = 5 x 60 = 300 in order to totalize in gallons.

If we wished to totalize in tenths of a gallon the K-factor would be 5 x 60/10 = 30

Example 4
An electromagnetic flow meter outputs 20 mA when the flow is 20 liters per second, we wish to display the flow rate in liters per second and totalize in M^3.

The rate K-factor is 10000/20 = 500

The totalizer K-factor will be 500 x 1/0.001 = 500000

4. Multi-Point K-factors
Some flow applications dictate that multiple K-factors are used. Two applications that require multiple K-factors are:

- flow meters with non linear outputs
- wide turndown flow applications

KEP meters have an option available that allows the user to input from 3 to 16 K-factors. This multi-point K-factor option is available for both pulse and analog inputs.

5. Multi-Point K-factors for Pulse inputs
The first step is to calculate K-factors to cover each flow range. This is done by taking the information on the flow meter manufacturer's calibration sheet and calculating the K-factors as per section 2. An alternative to using the manufacturers' data is to conduct tests on site against a calibrated standard.

The second step is to relate an incoming frequency range from the flow meter to a given calculated K-factor.

The final step is to program these values into the KEP instrument.

Example 5
A turbine flow meter has the following calibration data.

% Flow	Flow Rate (gpm)	Total Pulses	Frequency (Hz)	Pulses Per Gallon	Kfactor (ppg)
0	0	0	0	0	0
20	10	510	8.5	51	51
40	20	1025	17.08	51.25	51.25
60	30	1550	25.83	51.667	51.667
80	40	2080	34.67	52	52
100	50	2620	43.67	52.4	52.4

From the above calibration sheet data we can relate the incoming frequency to the K-factor as follows.

Input Frequency (HZ)	K-factor
0	51
8.5	51
17.08	51.25
25.83	51.667
34.67	52
43.67	52.4

The 16 point K-factor would be programmed as follows.

Display Prompt	Value to Enter	Comments
Enter Point Freq01?	0	enter frequency value for point 1
Freq01? 0.0000 K Factor01?	51	enter K-factor to be used for frequencies 0 to 8.5 Hz
Enter Point Freq02?	8.5	enter frequency value for point 2
Freq02? 8.5000 K Factor02?	51	enter K-factor to be used for frequencies 8.5 to 17.08 Hz
Enter Point Freq03?	17.08	enter frequency value for point 3
Freq03? 17.0800 K Factor03?	51.25	enter K-factor to be used for frequencies 17.08 to 25.83 Hz

Enter Point Freq04?	25.83	enter frequency value for point 4
Freq04? 25.8300 K Factor04?	51.667	enter K-factor to be used for frequencies 25.83 to 34.67 Hz
Enter Point Freq05?	34.67	enter frequency value for point 5
Freq05? 34.6700 K Factor05?	52	enter K-factor to be used for frequencies 34.67 to 43.67 Hz
Enter Point Freq06?	43.67	enter frequency value for point
Freq06? 43.6700 K Factor06?	52.4	enter K-factor to be used for frequencies from 43.67 Hz onwards
Enter Point Freq07?	43.67	enter frequency value for point
Freq07? 43.6700 K Factor07?	52.4	enter K-factor to be used for frequencies from 43.67 Hz onwards

Note that because the K-factor for the last two points are the same, any frequency higher than 43.67 Hz will be modified by a K-factor of 52.4 The set up is now complete.

6. Multi Point K-factors for Analog Inputs

The procedure for analog inputs is essentially the same as for pulse inputs.

The first step is to calculate K-factors to cover each flow range. This is done by taking the information on the flow meter manufacturer's calibration sheet and calculating the K-factors as per section 3. An alternative to using the manufacturer's data is to conduct tests on site against a calibrated standard.

The second step is to relate an incoming flow value from the flow meter to a given calculated K-factor.

The final step is to program these values into the KEP instrument.

Example 6

A vortex flow meter has the following calibration data.

Base K-factor 10000/100 = 100

Output (mA)	True Flow Rate (gpm)	Indicated Flow Rate (gpm)	Ratio (Actual:True)	K-Factor (base x ratio)
4	0	0	1	100
8	25	25	1	100
12	50	51	1.02	102
16	75	78	1.04	104
20	100	105	1.05	105

Using the MASStrol as an example the K-factors would be programmed as follows.

Display Prompt	Value to Enter	Comments
Enter Point Actual01?	0	enter flow value for point 1
Actual01? 0.0000 K Factor01?	100	enter K-factor to be used for flows 0 to 25 gpm
Enter Point Actual02?	25	enter flow value for point 2
Actual02? 25.0000 K Factor02?	100	enter K-factor to be used for flows 25 to 50 gpm
Enter Point Actual03?	50	enter flow value for point 3
Actual03? 50.0000 K Factor03?	102	enter K-factor to be used for flows 50 to 75 gpm
Enter Point Actual04?	75	enter flow value for point 4
Actual04? 75.0000 K Factor04?	104	enter K-factor to be used for flows 75 to 100 gpm
Enter Point Actual05?	1000	enter flow value for point 5
Actual05? 50.0000 K Factor03?	104	enter K-factor to be used for flows 100 to 1000 gpm

Note that the point after the final one should have a flow value entered that is very much higher than the true maximum flow rate of the meter. Note also that as the last two K-factors are the same any flow above 100 gpm will be modified by a K-factor of 104. The setup is now complete.