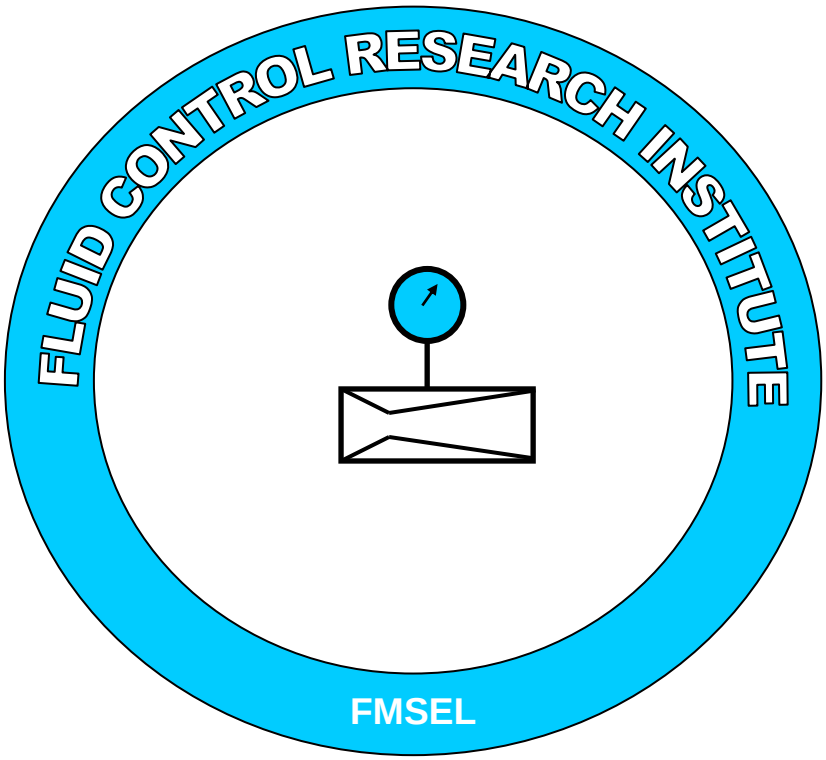
एफ.सी.आर.आई.

FLUID CONTROL RESEARCH INSTITUTE

FMSEL 2.0

A SOFTWARE FOR FLOWMETER SELECTION AND SIZING



FLUID CONTROL RESEARCH INSTITUTE
KANJIKODE WEST
PALAKKAD – 678 623
KERALA - INDIA

FCRI SOFTWARE ACTIVITIES

Web site: www.fcriindia.com E-mail :customercare@fcriindia.com ☏ : 91 491 2569010/2566120/2566206/2566119

PRECISE

- **Has standardised, time proven method, with correction factors automatically calculated for greater accuracy.**
- **Agrees with miller's method within very close limits.**

COST EFFECTIVE

- **Saves both time and the cost of vendor calculations**
- **Makes economic choice between different type of flowmeters like positive displacement type, electro magnetic type etc.**

CONVENIENT

The software is very easy to use, supported by a full fledged DATA BASE file for change of units, fluid/ material properties etc.

HARDWARE REQUIREMENTS

In general the software requires 640 KB RAM, DOS 6.2 version and VGA monitor. FMSEL 2.0 requires ACAD ver 10. for Engineering Drawing.

FMSEL 2.0

A SOFTWARE FOR FLOWMETER SELECTION AND DESIGN

Introduction

Fluid flow is one of the most important parameters to be measured in any process lines. There are various types and sizes of flowmeters are available commercially. No single meter is suitable for all applications, there by necessitating the need for proper selection based on the application. The selection of flowmeter for a required duty is complex and the consequences of an incorrect selection are loss of performance, time and money, with the possibility of damage to the equipment and installation. Various basic criteria which have to be taken into consideration while selecting the flow meter for any application are pipe size, range, accuracy, temperature effect, pressure variation, viscosity, conductivity , as also usage and economy.

Fluid Control Research Institute (FCRI), dedicated to research works on fluid flow control, measurement and fluid power as well as calibration/testing of flow meters /control valves have come across problems related to flow metering in various process industries, Water Authorities, Power Stations, Water and Gas distribution networks etc.

With this vast experience and the urging demand from industries, FCRI has developed a software, FMSEL 1.0. Over the time, demand for design of flowmeters to suit a particular application also was felt. As a result , with the inclusion of design of flow meters, FMSEL 1.1 was released. FMSEL 1.2 is an improved version of this including the design of miscellaneous types of flow meters like pitot tube, pipe bend, intake cone etc along with the conventional and other differential types of flow meters.

FMSEL 2.0 is the latest version of this software, which includes the Engineering drawing along with the design.

GENERAL FEATURES:

It is menu driven and very user friendly. The inputs are through pull down and pop up menus. Extensive error trapping is provided to catch the most likely input errors. The user is given the choice to input data in any system of units. Data tables showing the properties of materials, fluids and steam etc are stored and is being used in the software for processing.

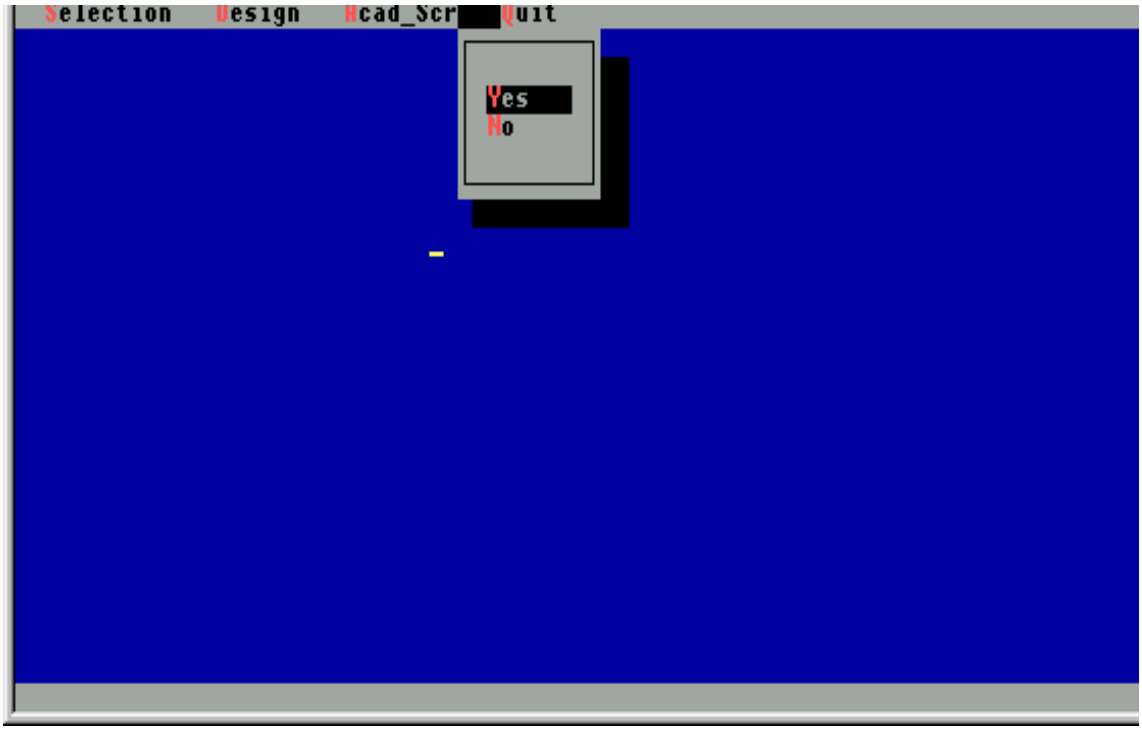
FMSEL consist of three parts

a. **Flowmeter SELECTION:** This part makes use of figures and tables to indicate, (by process of elimination) those metering techniques which do not match the user's application. The aim is to restrict the choice of meter(s) to those that meet or nearly meet the requirements.

b. **Flowmeter DESIGN:** This part of the software gives the flow meter design, by making individual selection. If the design parameters are found unsuitable, reason for not giving the design values are displayed as message. Once the design is completed , the

calculated values like Reynolds Number, beta ratio etc are checked against the limiting conditions given by BS/ISO/AGA standards. .It includes the design of Concentric/ Non Concentric Orifice Plates ,Nozzles (ISA 1932, Long Radius, Critical Venturi) , Venturi tubes (Classical / Others) and other differential types.

c. **Flowmeter DRAWING:** Engineering drawing includes the differential types of flowmeters along with flange details etc as per BS 1042/ASME standards. This requires ACAD Version 10.



The Program Description Menu

PROCEDURE:

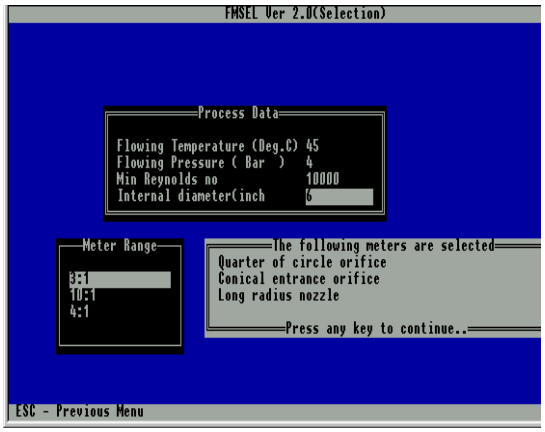
FLOWMETER SELECTION

The selection begins with the option of the type of fluid to be metered. The procedure is then to examine, in more detail the basic areas which define the application as follows:

- Performance considerations, which include meter rangeability, pressure loss, overall approximate error etc.
- Fluid property considerations, which include fluid type (liquid or gas), temperature, pressure, viscosity, density etc.
- Installation and maintenance considerations like the upstream straight-length of the pipe required, maximum and minimum line size, service etc.
- Environmental considerations such as temperature effects, pressure effects etc.
- Economic consideration like relative prevailing cost, life expectancy, maintenance etc.

Meters which can be selected are

1. Flow nozzle:
   - ISA 1932 Nozzle
   - Long Radius nozzle
2. Other differential types:
   - Eccentric and segmental orifice
   - Pitot tube
   - Target meter
   - Conical entrance and Quarter circle orifice plate
3. Positive displacement types:
   - Positive displacement meter.
4. Rotary turbine type meters:
   - Turbine meter
5. Fluid oscillatory types:
   - Vortex meter
6. Electromagnetic meter:
   - Magnetic meter
7. Ultrasonic types:
   - Ultrasonic meter
8. Direct and indirect mass types:
   - Coriolos meter
9. Miscellaneous types:
   - Rotameter
   - Pipe bend



INPUT DATA (Selection):

The following data has to be supplied by the user for selection.
Fluid type: Liquid, gas, steam
Fluid characteristics: viscous, clean, dirty, conductive etc.
Meter range
Pressure loss
Field application
Operating conditions: max. temperature, max. pressure, line size, minimum Reynolds number etc.

OUTPUT DATA (Selection):

The following specification of the selected meter is given as output:
Flowmeter selected
Installation condition
Construction material
Relative price
Relative life
Specification
Advantages and disadvantages
Overall approximate error etc.

FLOWMETER DESIGN

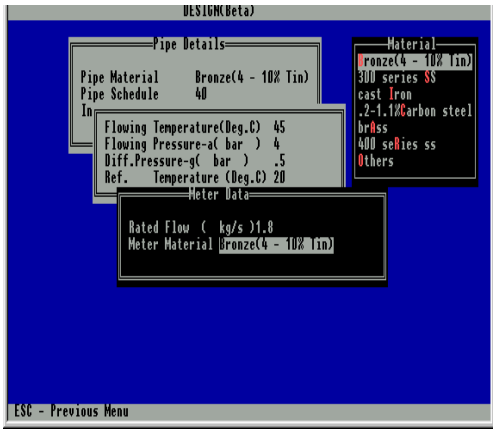
The software is designed to be a general program which can be used to design flowmeters described in BS 1042.

- Calculates pipe diameter (corrected to operating temperature), beta ratio, coefficient of discharge, Reynolds number, exact differential pressure, pressure drop, tolerance limit etc.
- Performs calculations for liquids, gas, steam and natural gas. For natural gas, correction factors Fb, Fpb, Ftb, Ftf, Fgr, Fpv,Fr etc. are calculated based on AGA3, ANSI/API standards.
- Vent hole correction factor and Reynolds number are calculated based on temperature and pressure variation in the fluid stream.
- Appropriate messages are displayed if the calculated parameters are unsuitable as per the standards.
- Upstream and downstream straight length is calculated based on the type of pipe fittings selected.

INPUT DATA (Design)

The following details are required for the design of the flowmeter.

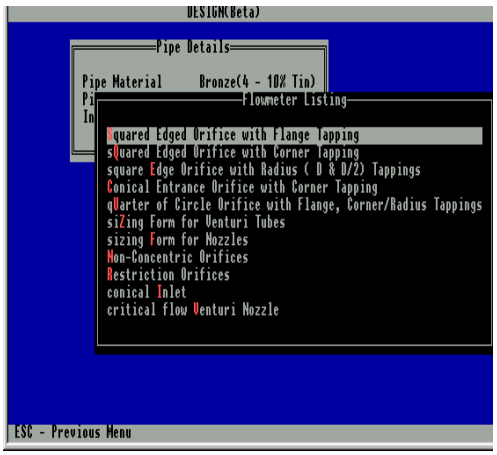
- Fluid type: liquid, gas, steam and natural gas
- Process data: operating conditions, line size, meter material etc.
- Design criteria: beta ratio or flowrate, differential pressure etc.
- Installation conditions: details of the pipe fittings upstream/downstream side



OUTPUT DATA (Design)

The output sheet contains the following details

- Fluid type (With properties)
- Pipe details (material specifications, pipe correction factor etc.)
- Meter data (beta ratio, thickness, tolerance, meter factor, vent hole correction factor, pressure ratio, Reynolds number, Cd, expansion factor coeff, etc.)
- Installation conditions
- Pressure drop etc.



SAMPLE OUTPUT [FMSEL Ver. 2.0]

SELECTION

Flowmeter Details

Flow Meter Selected	:	Venturi tube
Fluids Supported	:	Liquid, Gas , Steam
Maximum Line Size	:	800 mm
Minimum Line Size	:	100 mm
Maximum Temperature	:	500 deg C
Maximum Pressure	:	400 bar (abs)
Minimum Reynold's Number	:	2E+05

Application consideration

Meter Rangebility	:	3
Possible Construction Material	:	Metals, plastics

Overall Approximate Error Percentage

Uncalibrated	:	1.7 %
Calibrated	:	0.75 %

Installation Conditions

Straight Length of Pipe is required at the upstream side of the flowmeter.

Economic Considerations

Relative Price	:	Inexpensive
Relative Life Expectancy		
Minimum Life	:	2 years
Maximum Life	:	10 years
Maintenance	:	Periodic check
Pressure Loss	:	Low
Field Of Application	:	Accurate measurement
Specific Advantages	:	Low pressure loss, accurate
Specific Disadvantages	:	Size

Flowmeter Sizing using BS 1042, Section 1.1..1.4,1984 - 1992,ISO 5167 - 1980 –1991 and Fluid meters their theory and applications, 6th edition, 1971, Part I and II & AGA

Client	:	
Tag/Item No	:	FE 01
Executed by	:	FCRI
Date	:	11.09.1997
Project	:	
Service	:	Gas
Type of Fluid	:	Gas (air)
Meter Material	:	Bronze (4 - 10% Tin)
Pipe Material		Bronze (4 - 10% Tin)
Flow Meter	:	**Squared Edged Orifice with Flange Taps**
Internal Diameter of Pipe(Ref. Temp) (D)	:	154 mm
Pipe correction factor	:	1.0007
Operating Temperature (t)	:	60 deg.C
Operating Pressure (p)	:	4.3 Bar
Density of Fluid (Op. Condn)	:	4.5 Kg/m^3
Viscosity (Op.condn)	:	0.02004 cP
Isentropic Exponent	:	1.41
Compressiblity factor	:	0.99910218
Rated Flow (qm)	:	1.818 Kg/s
Reference Temperature	:	20 deg.C
Differential Pressure at meter max (kp)	:	704.4 mm. H 20
Pressure ratio (P2/P1)	:	0.984
Reynold's Number (ReD)	:	7.495 E05
BETA ratio	:	0.7402
Diameter of the Vent Hole	:	3.96 mm
Orifice Diameter (Ref.Temp)	:	113.99 mm
Thickness of the orifice plate (e)	:	1.9264 mm
Differential Pressure Used for this calculation	:	704.4 mm.H20
Coefficient of Discharge (C)	:	0.6007
Meter correction factor	:	1.0007
Orifice Plate Flatness Tolerance	:	0.105 mm
Expansibility factor	:	0.9941
Pressure Loss	:	306.6 mm. H20
Upstream connection	**:**	**Single 90 degree bend or tee**
Recommended Straight Length		
Upstream	:	5306 mm
Downstream	:	1203 mm

References

BS 1042 Sec.1.1, Sec.1.2, Sec.1.4, 1984 1992

ISO 5167 1980…..1991

Fluid meters their theory and applications, 6th edition, 1971, Part I and II

AGA 3, API 2530, ANSI/API 2530 - 1985, API MPMS 14.5

ISO 9300 - 1990, ASME - MFC 3M – 1985

ASME - MFC - 10M - 1988, ASME B 16.36 – 1996

ISO/TC/30/SC2/WG5

ISO 5024

Flow measurement engineering hand book by R.W. Miller