YILDIZ TECHNICAL UNIVERSITY

INDUSTRIAL MEASUREMENT SYSTEMS
MKT 4171

KEMALETTIN KARA 1806A004

PROJECT

LECTURER: KADIR ERKAN

Project

Suggest a sensor that could be used as part of the control system for a furnace to monitor the rate at which heating oil flows along a pipe. The output from the measurement system is to be an electrical signal which can be used to adjust the speed of the oil pump. The system must be capable of operating continuously and automatically, without adjustment, for long periods of time. Sketch the control block diagram and explain operating principles. Outline the sensor specifications. (Hint: You can search for a candidate sensor in internet to determine precisely the specifications…)

- **Late submission will not be accepted!**
- Prepare a homework report containing
  - Analytical calculations
  - Associating Matlab program and if required a plot or plots
  - Verification of the results by analytical calculations and respective Matlab outputs
- The report must be handed in a single pdf file through the online system of YILDIZ TECHNICAL UNIVERSITY
- Computer typing is prohibited except the graphs, schematics and programming codes!!! All explanations and analytical calculations must be **handwritten**!!!

IMS - Project

Kemalettin KARA
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There are several type of flow meter for these purposes.

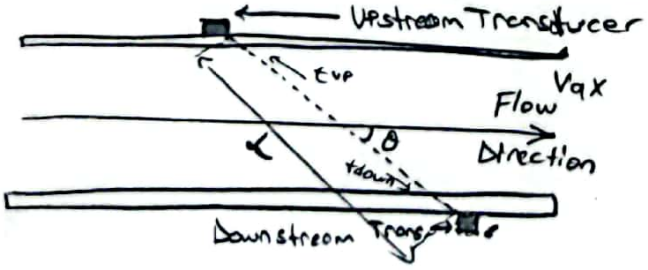
- Turbine flow meter
- Coriolis flow meter
- Vortex flow meter.

According to my research heating oil temperature range from 10°C - 204°C and I suggest Vortex flow meter. Vortex flow meter can typically withstand temperatures ranging from -40°C to 250°C

Working Principle

A vortex flow meter utilizes the fluid dynamics principle of vortex shedding to calculate the velocity of liquids, geses and steams, across a wide variety of application.

-> Vortex meters use a dimensioned bluff, sometimes called a shedder bar to generate the phenomenon known as kármán vortex street in which vortices begin to form and oscillate. Using a variety of sensor technologies, the naturel frequency of these oscillating vortices is converted into a digital signal which is then processed through the meter's electronis to calculate flow.



$$f = St \times V/d$$

f = Kármán vortex freaquency
St = Strouhal number
V = Velocity
d = width of the triangular cylinder.

Because of the volumetric flow rate Q is the product of the average fluid velocity and of the cross sectional area available for flow (A)

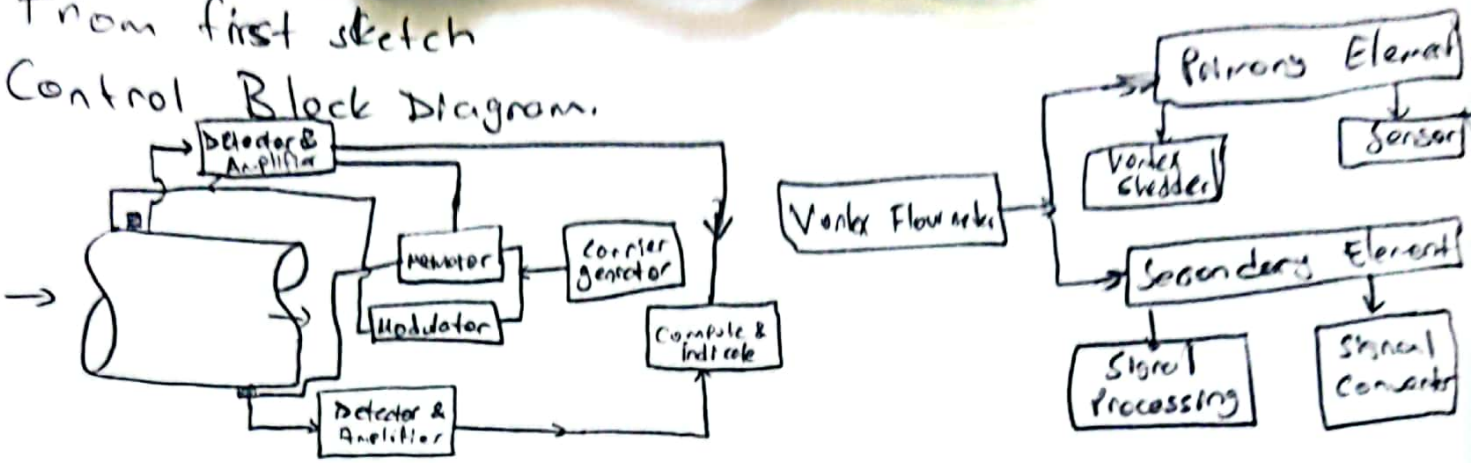
$$Q = A.V = (A.f.dB)/Sd$$

B is the blockage factor.

$$Q = f.k$$

From first sketch

Control Block Diagram.



Explanation of the operating block

Sensor element; is positioned in the flow stream to detect vortex shedding, which is caused by the flow of the fluid. The freqvency of the vortex shedding is proportional to the flow rate of the fluid, and the sensor element measures the freqvency of the vortex shedding.

Amplifying stage: Amplifye the detected signals.

Signal Processing Unit: The signal processing unit receives the flow rate signal processing unit and uses it to control or monitor the flow of the fluid. The output device could be a display, a control system, or some other type of device that uses the flow rate signal for some purpose.

Selected example of industrial application SUP-LUGB-B model

1. Medium: liquid, gas, steam(saturated steam and superheated steam)

2. Diameter Pipeline-version: DN15-DN300

3. Accuracy: Gas without compensation: DN15-DN25--1.5%, DN32-DN200--1.0%, DN250-DN300--1.5%;Liquid without compensation: DN15-DN300 -- 1.0%;Temperature and pressure compensation: DN25-DN300 -- 1.5%

4. Range ratio:

Gas density:1.2kg/m3, Range ratio: 8:1

Liquid density:1000kg/m3, Range ratio: 8:1;

when the medium density is different, the range ratio will change. 5. Pressure:

Wafer connection: DN15-DN300 PN2.5MPa

Flange connection: DN15-DN50 PN2.5MPa

Flange connection: DN65-DN200 PN1.6MPa

Flange connection: DN250-DN300 PN1.0MPa

Note : Other pressure or other flange standards can be customized

6. Medium temperature

-40° C ~ +260° C、-40° C ~ +300° C

7. Ambient conditions:

Ambient temperature: -20℃~+55℃

8. Relative humidity (RH): 5% - 95%RH

9. Atmospheric Pressure: 86kPa -106kPa

10. Electrical Interface: M20*1.5 internal thread (priority). 11. Power supply: 24VDC±5%, lithium battery 3.6VDC

12. Signal output :

Instantaneous flow under working condition corresponding voltage-frequency- pulse output (lower PWL≤1V, higher PWL≥6V); Instantaneous flow

corresponding 4-20mA output(Load resistance≤300Ω)

13. Communication interface: RS485 14. Ingress protection: IP65 15. Main body material: stainless steel 16. Pressure loss: △P≤1.2ρ 工 V 2 (△P unit is Pa, ρ 工 unit is kg/m3, V unit is m /s) 17. Calibration method: all flow meters should be calibrated in the way of lower reaches taking pressure before flow meters leave factory. 18. Display mode: Intelligent numeric alphabetic display type: twin-row numeric alphabetic LCD (instantaneous flow rate and totalizer) Intelligent dot matrix LCD: English 128*64 dot matrix LCD (instantaneous flow rate, totalizer, temperature and pressure under

working condition, battery voltage or density under working condition, instantaneous flow rate under working condition, send-out, time, menu modify records, power-off records, etc.