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APPENDIX A
PUMPING SYSTEMS

A1 The EXT 70 turbomolecular pump and the EXC 120 turbomolecular pump controller

The EXT 70 turbomolecular pump is designed for use with an Edwards EXC Controller. The EXT 70 turbomolecular pump is multi-stage axial-flow turbines, optimized for operation in molecular flow conditions. The internal structures of the EXT 70 turbomolecular pump show in Figure A1.

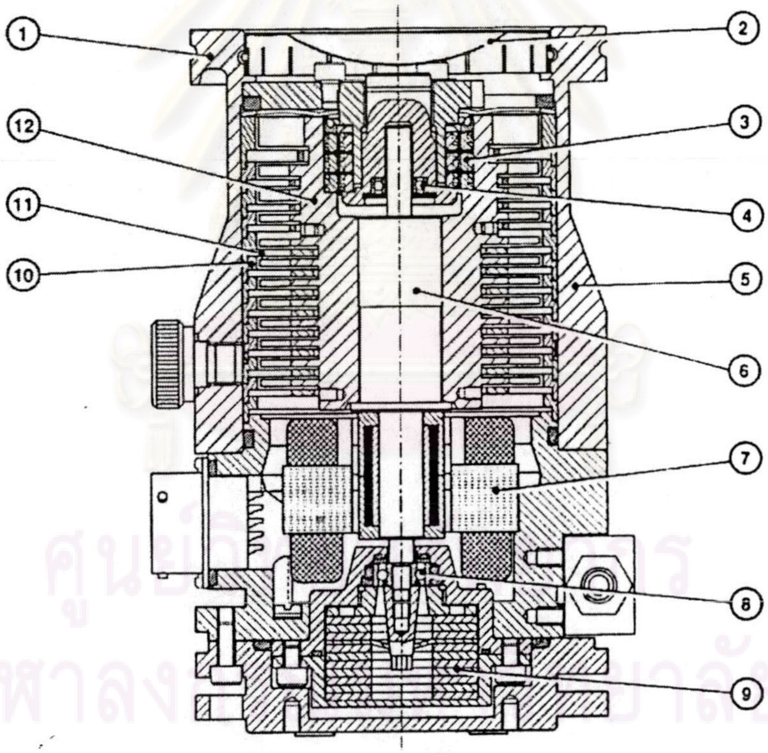

Figure A1: The internal structures of the EXT 70 turbomolecular pump

The multi-stage, light alloy turbine rotor (12) is machined from one piece to form rows of angled blades fitted to a central shaft (6). The blades of the rotor rotate between the blades of the stator. The stator assembly (11) is a series of thin disks separated by spacer rings (10). The blades are angled so that the gas in the vacuum chamber is compressed and is transferred from the pump-inlet to the outlet.

The rotor and stator blades have an open structure at the pump inlet and a more closed structure at the outlet. This configuration gives an optimum combination of pumping speed and compression when the pump is operated with gases of both high and low molecular weight.

The rotor is driven by a high-efficiency, brushless d.c. motor. The motor (7) has a magnetized rotor fitted onto the shaft, and a wound stator located in the pump-body. For the blades to be effective, their speed must be close to the thermal velocity of the gas molecules. The rotor is therefore rotated at up to 90000 r.min^{-1}.

The rotor assembly is supported at the inlet end by a frictionless magnetic bearing (3) and by a precision ball bearing (8) at the outlet end. The ball bearing is lubricated from an oil reservoir and wick mechanism (9).

EXT 70 pump is supplied with an inlet-screen (2) fitted in the bore of the inlet-flange. The inlet-screen protects from the sharp blades and also protects the pump against damage caused by debris, which falls into the pump.

EXT 70 pump has a vent-port, which can use to vent the pump and vacuum system to atmospheric pressure. The vent-port introduces vent gas part way up the pump rotor to ensure maximum cleanliness even with fluoroelastomer sealed vent-valves.

Electrical connection between the EXT and the EXC Controller is by a 19-way connector and a pump-to-controller cable.

The pump may be air-cooled using an optional air-cooler accessory, or water-cooled by passing water through the water-cooler provided. Two riffled hose connectors are provided for connection of your cooling-water supply and return pipelines. The EXT 70 may be cooled by natural convection to the surrounding air. A thermal sensor monitors the temperature of the motor and the pump-body.

The inlet-connection of the EXT pump is a CF Flange, which use the copper compression gasket supplied with the pump and use a full complement of both to connect the inlet-flange of the pump to the vacuum system.

The EXT 70 turbomolecular pump is used in this work shows in Figure A2.

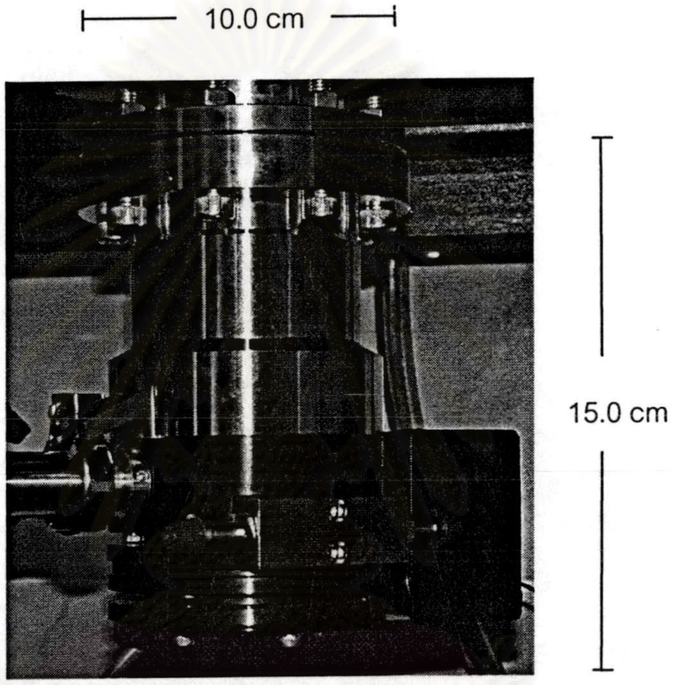

Figure A2: The EXT 70 turbomolecular pump

The EXT pump and its accessories are operated by The EXC 120 turbomolecular pump controller. The EXC 120 turbomolecular pump controller is used in this work shows in Figure A3.

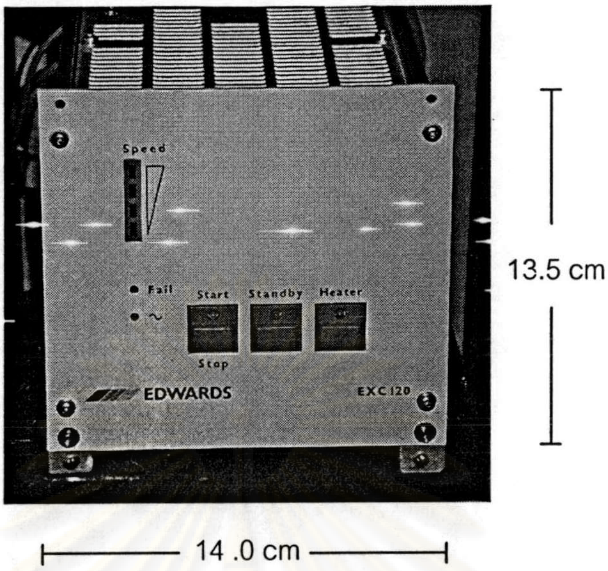

Figure A3: The EXC 120 turbomolecular pump controller

A2 The two stage rotary pump

The two stage rotary pump is used in this work shows in Figure A4.

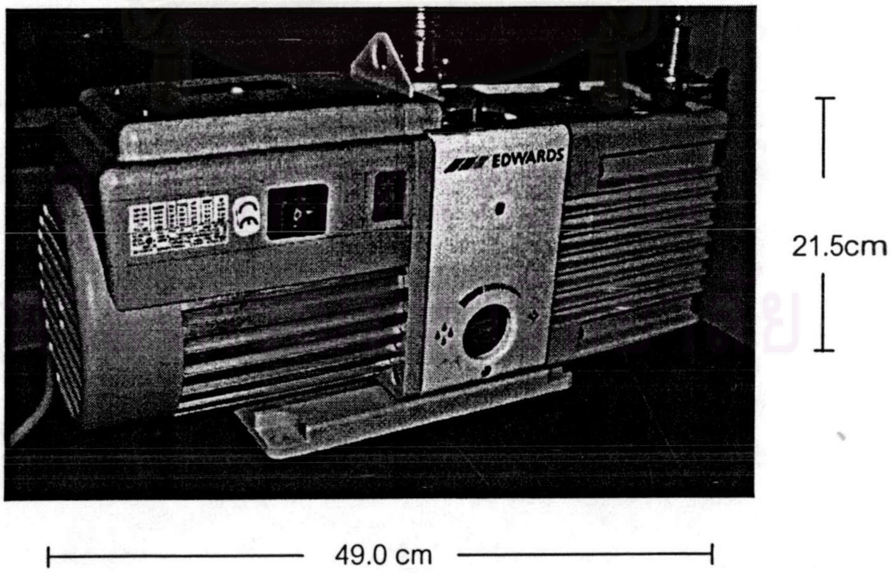

Figure A4: The two stage rotary pump

APPENDIX B
DESIGNED SYSTEM

B1 Components of the Reactor chamber

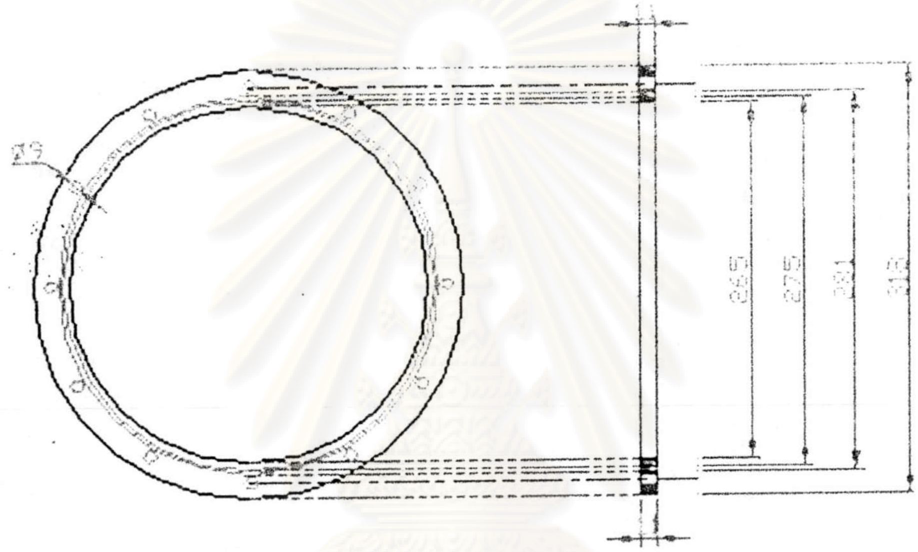

Figure B1: The top and the bottom ring plate of the chamber (in mm unit)

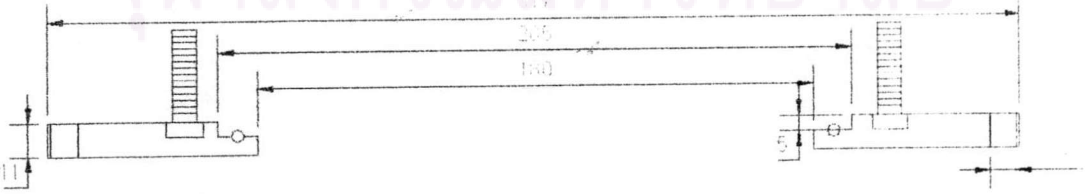

Figure B2: Cross section of the top plate of the chamber (in mm unit)

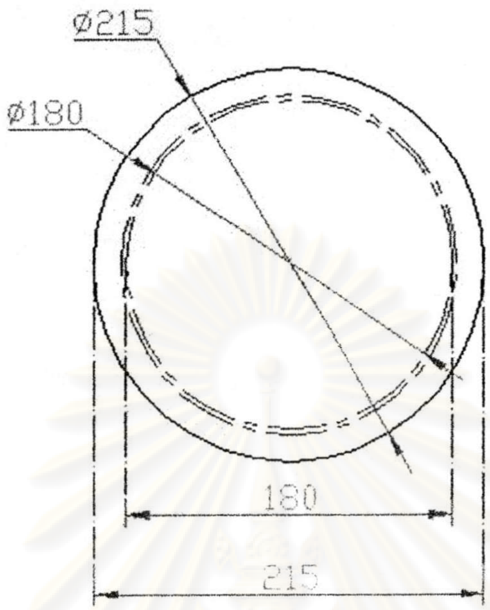

Figure B3: The holding ring plate (in mm unit)

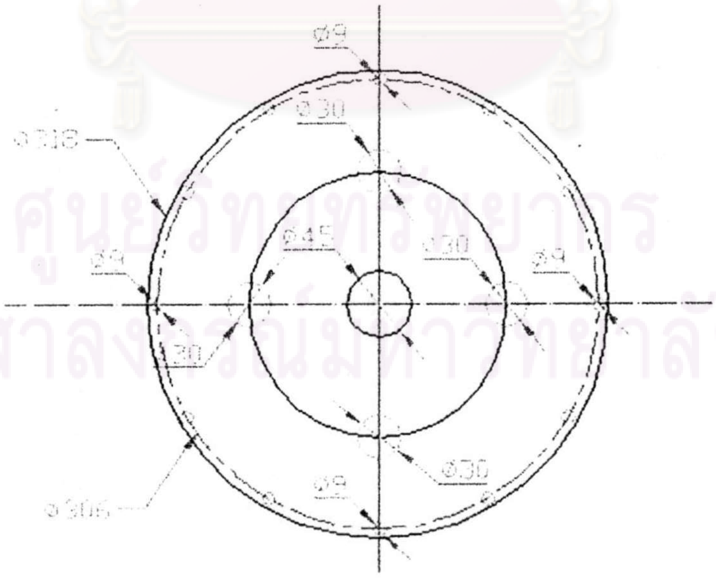

Figure B4: The bottom plate of the chamber (in mm unit)

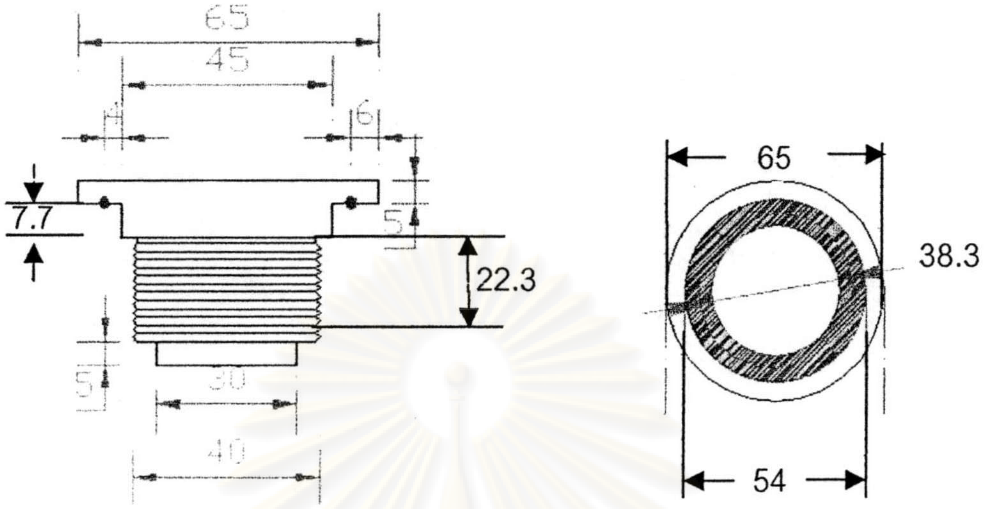

Figure B5: The NW 40 plug (in mm unit)

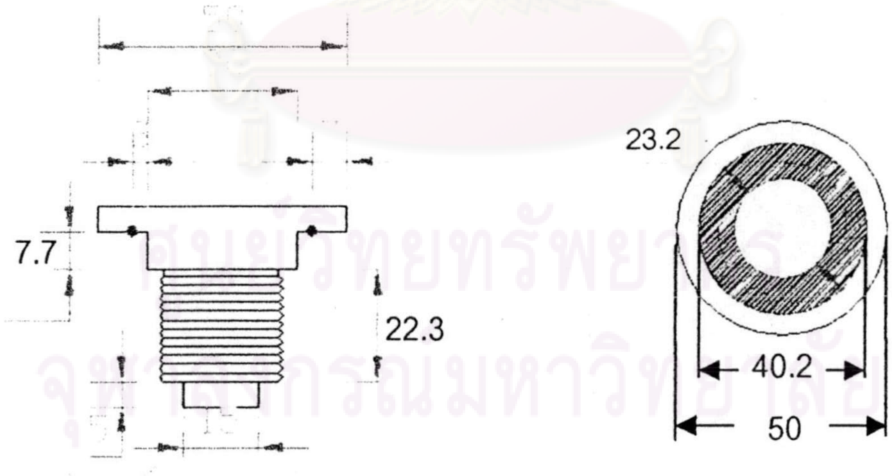

Figure B6: The NW 25 plug (in mm unit)

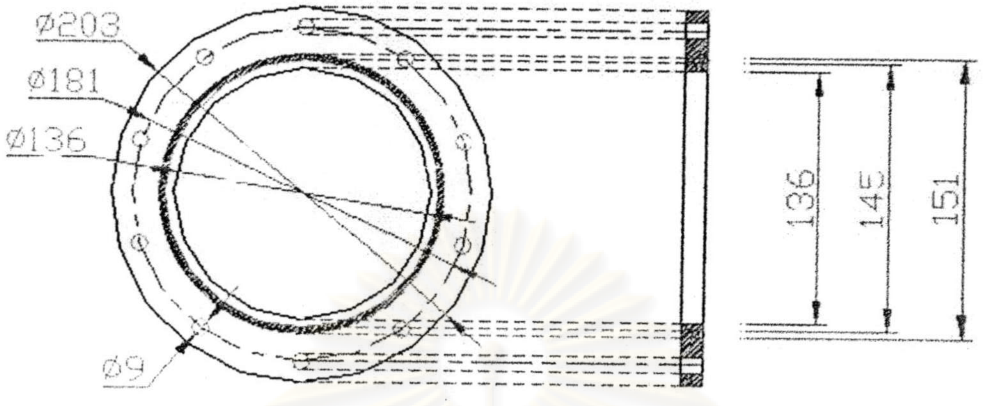

Figure B7: The front ring plate of the chamber (in mm unit)

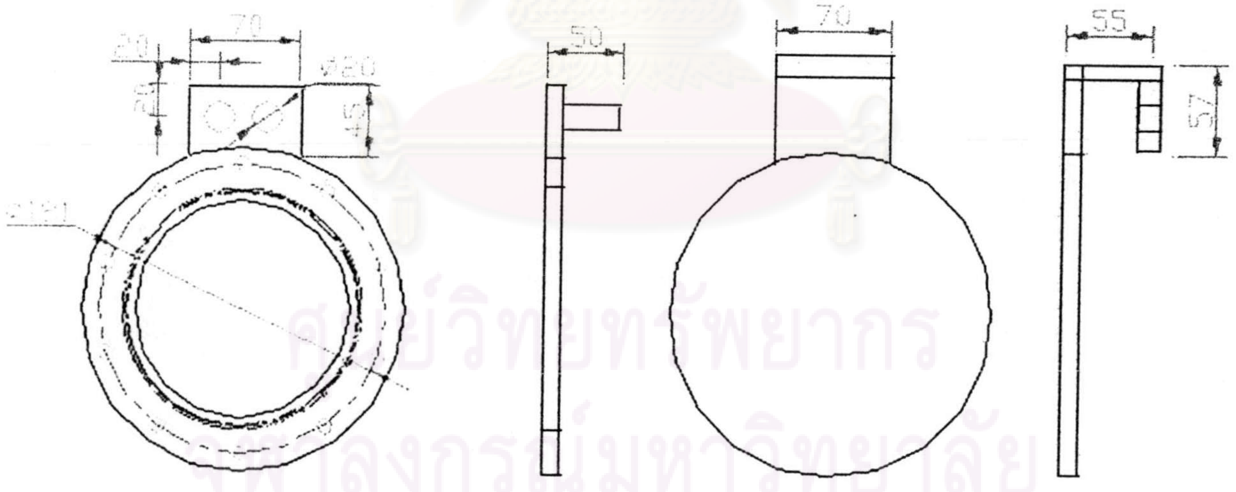

Figure B8: The door of the chamber (in mm unit)

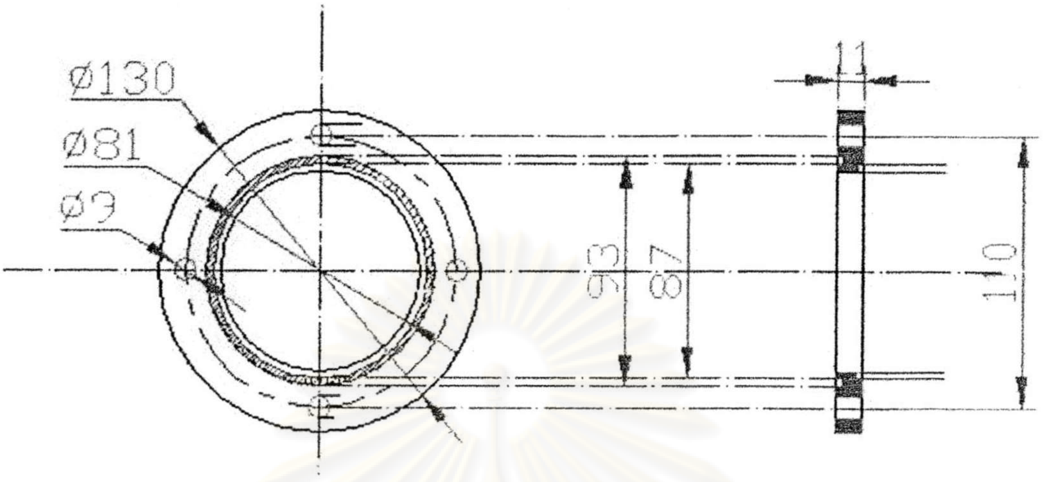

Figure B9: The plate of the back tube (in mm unit)

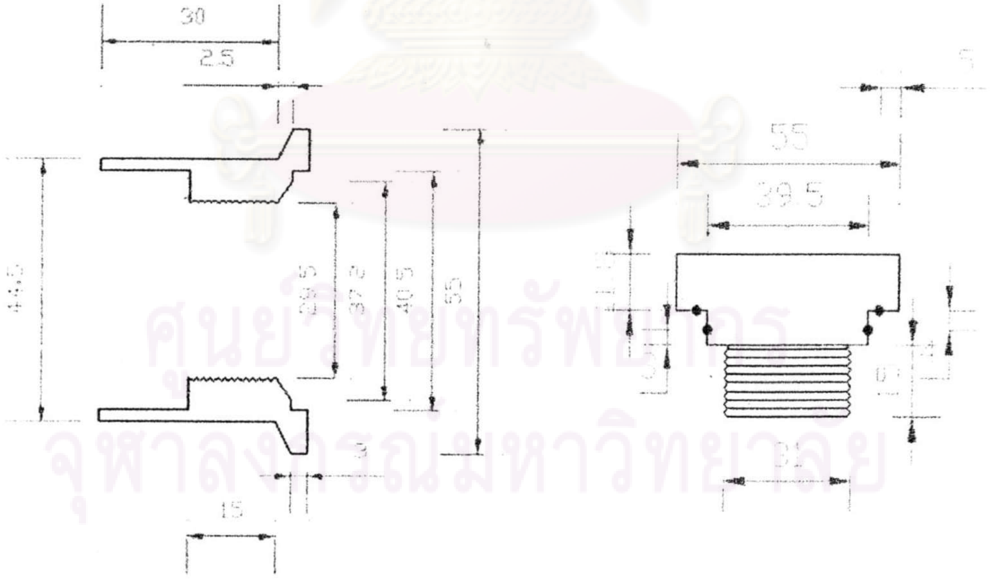

Figure B10: NW 40 tube and NW 40 plug (in mm unit)

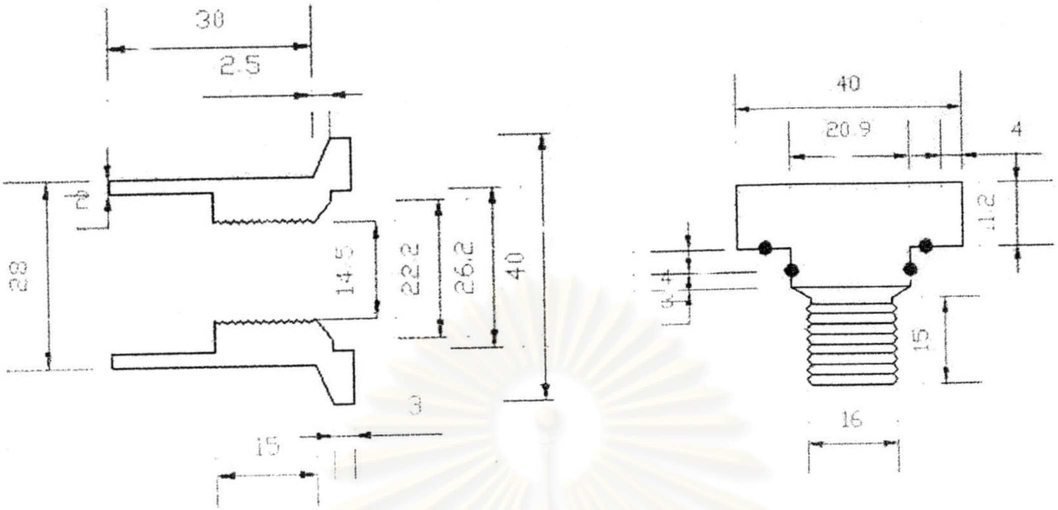

Figure B11: NW 25 tube and NW 25 plug (in mm unit)

B2 Components of Gate Valve

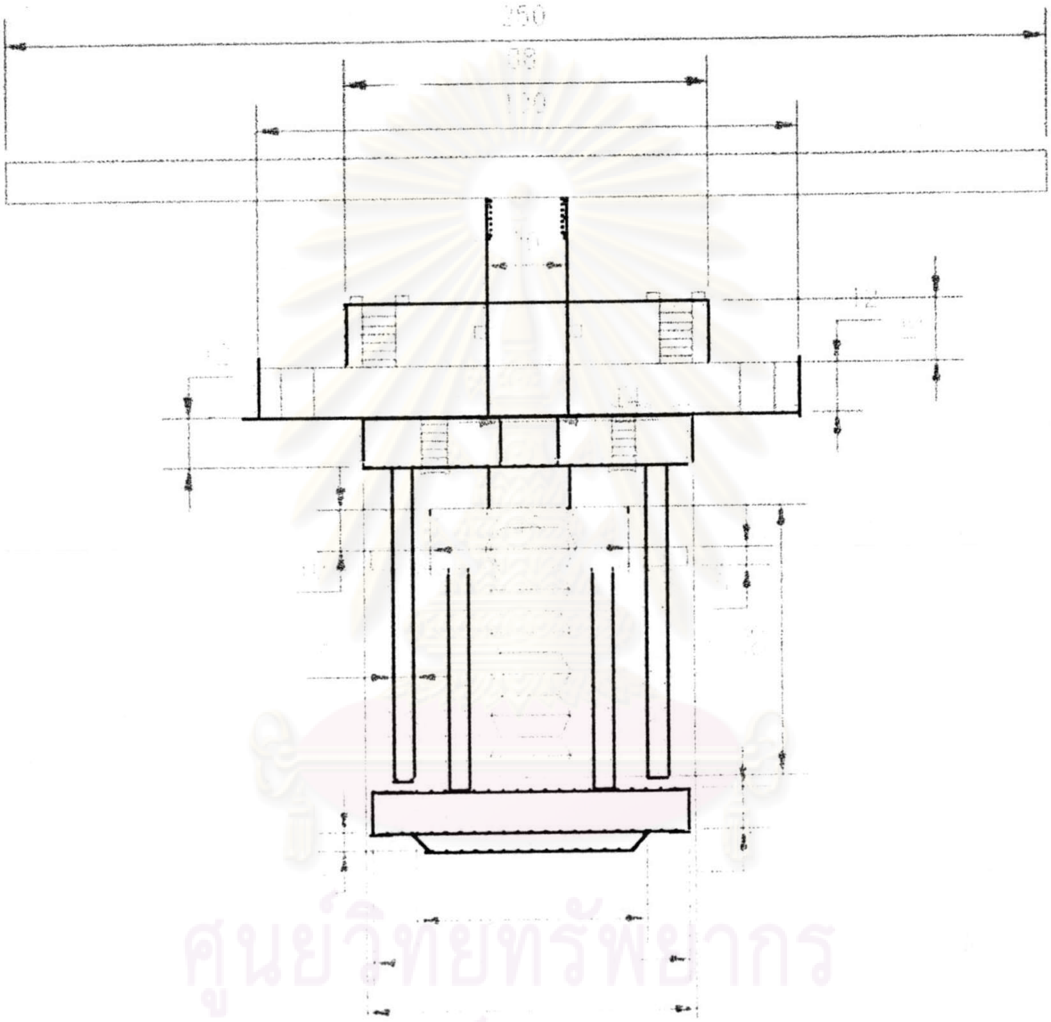

Figure B12: The cross section diagram of gate valve (in mm unit)

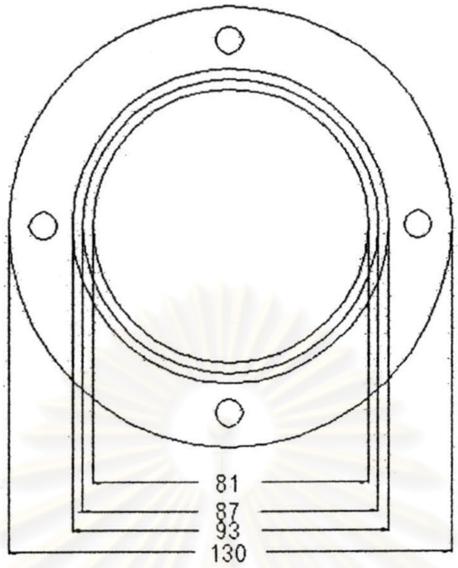

Figure B13: Flange (in mm unit)

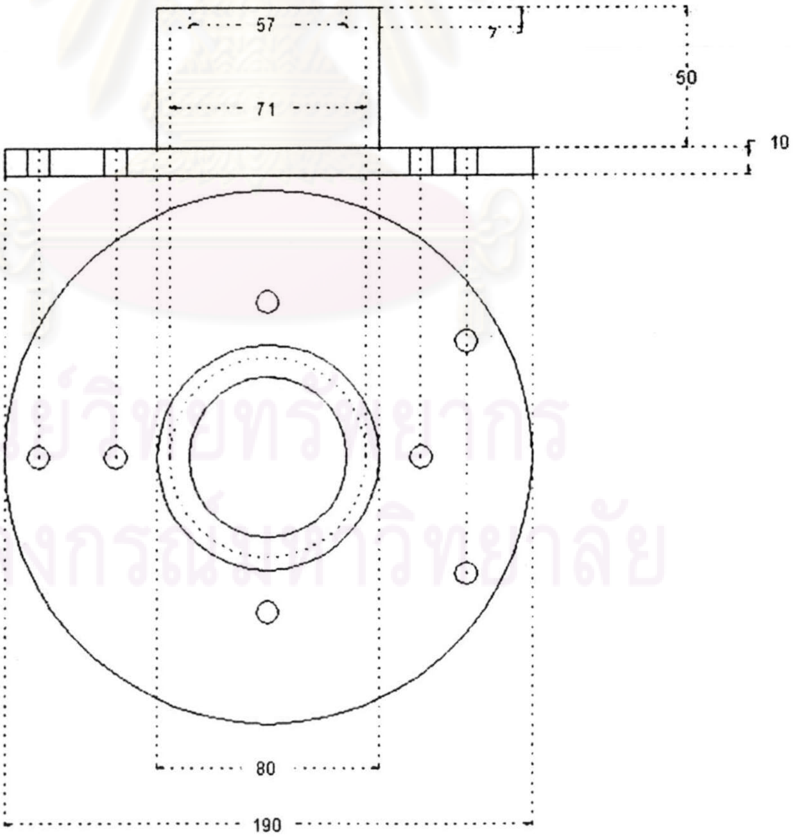

Figure B14: Base of gate valve (in mm unit)

APPENDIX C
CALCULATION OF SYSTEM

C1 Ultimate pressure of system

In calculation of value of vacuum system, can be compare with calculation of electrical circuit. By

Pressure (P) → Voltage (V)
Gas Flow (Q) → Current (I)
Volume (V) → Capacitance (C)
Conductance (G) → 1/Resistance (R)

So, total inductance (G_{eff}) can calculate from

$$\frac{1}{G_{eff}}=\frac{1}{G_1}+\frac{1}{G_2}+\frac{1}{G_3}+...$$

In this system, instruments of system are designed in a cylindrical form. G can calculate from equation,

$$G=\frac{12.1x\phi^3}{\ell}$$

Where ℓ is the length of tube
ϕ is a diameter of tube

So,

$$G_{eff}=\left[\frac{1}{G_C}+\frac{1}{G_I}+\frac{1}{G_V}+\frac{1}{G_P}\right]^{-1}$$

Where G_C is the inductance of chamber

G_I is the inductance of tube

G_V is the inductance of valve

G_P is the inductance of pump

We can find ultimate pressure of system from,

$$P_F = P_P + \frac{L}{G_{eff}}$$

When P_F is ultimate pressure of system

P_P is ultimate pressure of pump

And gas load (L) can calculate from equation,

$$L = I + (AxO)$$

When I is leak rate

A is total area

O is outgassing rate

If t is pumping time and V is total volume, we obtain

$$t = \frac{V}{G_{eff}}$$

From equation $$G = \frac{12.1 x \phi^3}{\ell}$$

In this work, we get $G_C = 7564.5\ \ell/s$ (ϕ=10.8″, ℓ=13″)

$G_I = 4.78\ \ell/s$ (ϕ=0.95", ℓ=14")

$$G_V = 713 \ \ell/s \ (\phi=4", \ell=7")$$

$$G_{P1} = \text{inductance of turbomolecular pump}=70 \ \ell/s$$

$$G_{P2} = \text{inductance of rotary pump}=150 \ \ell/s$$

So, $$G_{eff} = 4.32 \ \ell/s$$

Leak rate is $9.7x10^{-5}$ ℓ/s and outgassing rate of stainless is $2.5\text{x}10^{-8}$ torr ℓ/s cm^2

Ultimate pressure of turbomolecular pump is 10^{-5} torr, we obtain

$$P_F = 6.25x10^{-5} \quad \text{torr}$$

C2 Resonance frequency (f_r)

In LCR circuit, we obtain

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Where L=inductance of planar coil=45.6 μH

And C=capacitance of vacuum capacitor

In this work, f_r = 13.56 MHz

So,

$$C = 137.9 \ \text{pF}$$

A variable vacuum capacitor that use in this work, with the capacitance rang 10pF-1000pF.

APPENDIX D
LIST OF ACRONYMS

RF-PECVD = Radio Frequency Plasma Enhanced Chemical Vapor Deposition

IR Spectroscopy = Infrared Spectroscopy

NMR Spectroscopy = Nuclear Magnetic Resonance Spectroscopy

PCVD = Plasma Chemical Vapor Deposition

PECVD = Plasma Enhanced Chemical Vapor Deposition

APCVD = Atmospheric Pressure Chemical Vapor Deposition

ICPs = Inductively Coupled Radio Frequency Plasma Source

RF ICP = Radio Frequency Inductive Coupled Plasma

CCP = Capacitively Coupled Plasma

ICP = Inductively Coupled Plasma

RF = Radio Frequency

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