Operation of vacuum system for PEFP 100MeV DTL

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1. Introduction

A 100MeV proton linear accelerator is being developed by Proton Engineering Frontier Project (PEFP) that is made of ion source, Radio Frequency Quadrupole (RFQ), Drift Tube Linac (DTL), Low Energy Beam Transport (LEBT), Medium Energy Beam Transport (MEBT) and beam line. Also we consider different vacuum system for each section. Vacuum configurations per tank in linac part consist of a scroll pump and turbo molecular pump (TMP) set, three ion pumps high and low gauges and gate valves. Scroll pump, TMP set is using for initial exhaust for low vacuum driven ion pump.

In this study, base on the calculated values we investigated configuration of 100MeV linear accelerator vacuum system.

2. Formulas for vacuum

Calculate of critical values of 100MeV Drift Tube Linear accelerator (DTL). We expect that parameters of vacuum pump for correct design of the vacuum system.

2.1 Throughput

This formula is a Relational expression of pumping speed and pressure.

$$Q = C(P - P_1) = P_1 \cdot S_p = P \cdot S_e$$

$$\frac{1}{S_e} = \frac{1}{S_p} + \frac{1}{C}$$

$$S_e = \frac{S_p \cdot C}{S_p + C}$$

To obtain the lowest pressure, pumping speed (S_e) value is lower or larger Q value. Also result of increasing the conductance is pumping speed of vacuum pump (S_p) close the effect pumping speed (S_e) [1].

2.2 Conductance of port in 100MeV DTL

$$C_{total} = \frac{1}{\left(\frac{1}{C_{port}} + \frac{1}{C_{grill}}\right)}$$

When the conductance of vacuum port is calculated, it is considered separately each part of rectangular grill and circular tube.

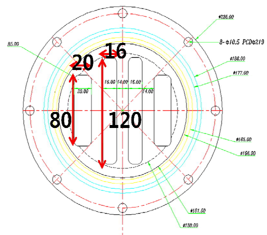

Fig.1. Vacuum port of tank

$$C_{circular} = 46.2 \frac{28 + 8\frac{L}{d}}{14 + 3\frac{L}{d}} \left(\frac{d^3}{L}\right)$$

$$C_{rec\tan gular} = 313.8 \times k \ \frac{a^2 b^2}{(a+b) \times L}$$

The main parameters of the vacuum component are listed in that and table I[2].

Outgasing rate of plate with copper Tank: 2.05E-10 (Torr·l/s·cm^2)
S_p : pumping speed of TMP = 300 l/s
S_p : pumping speed of Ion pump = 300 l/s
Conductance C = 293.8 l/s

Table I: Values of 100MeV DTL

Parameters	Tank(Aver. 1~7)
Energy(MeV)	100.0
length(cm)	674
# of DT	34
Sum of DT length(cm)	496.9
Surface of Tank(cm^2)	114962.0
Surface of DT(cm^2)	26659.2
Sum of Surface(cm^2)	141621.2
Surface Outgas load Q (Torr l/s)	5.17E-07
Total Outgas load Q (Torr l/s)	1.02E-06
Pressure TMP (Torr)	1.96E-07
Pressure Ion Pump (Torr)	6.54E-08

3. Vacuum system

100MeV DTL vacuum system and beam line vacuum system is generally designed.

3.1 Composition of vacuum component in DTL section

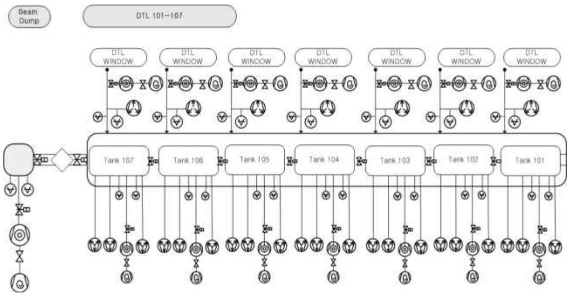

Fig.2. Layout of 100MeV DTL vacuum system

This layout represents the placement of vacuum components, and necessary components are listed in table Ⅱ.

Table Ⅱ: Components for Designed 100MeV DTL

Window		
Component	specific	Quantity
Scroll pump	100 l/m	13
TMP	75 l/s	13
Gate valve	8 inch	13
NEG pump	1300 l/s	17
Gauge	High vacuum	15
Gauge	Low vacuum	11
Tank		
Component	specific	Quantity
Scroll pump	250 l/m	17
TMP	300 l/s	17
Gate valve	8 inch CF	17
Gate valve	2 inch CF	15
ion pump	300 l/s	35
Gauge(high)	High vacuum	16
Gauge(low)	Low vacuum	16
Gauge controller	Multi-gauge	17
Bellows	2 inch CF	17

3.2 Beam line

The parameters of the vacuum component in beam line are listed in that table Ⅲ.

Table Ⅲ: Component list for 100MeV Beam line vacuum

Component	Quantity
Bellows (6”CF)	2
FCV	1
Vacuum gauge	1
TMP +G/V	1
Ion pump	1
Scroll + gauge	1

4. Conclusion

Operation of vacuum system proceeds as follows. DTL tanks are using scroll pump to the initial exhaust pressure of 5E-2 Torr and TMP make pressure of 2E-7 ~ 3E-6 Torr after than NEG pump pressure of 1.6E-8 ~ 2.7E-6 Torr. Turn off the TMP, Ion pump as main pump is operated maintain at pressure 1E-8 Torr.

Part of beam line, gate valves of the target room and accelerator part is closed before ion pump maintain normal operation. Open the beam line gate valve when vacuum pressure less than 5E-6 Torr. Using AC Magnetic vacuum TR102, 103,104 are operated vacuum system at the same time.

ACKNOWLEDGEMENT

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REFERENCES

[1] Suk-Hee BAE. Vacuum Engineering. Korea economy newpaper. 2000. p.62-p.87.
[2] Final report (Development of medium energy linac systems). 2008. J. H. Jang. p.106-p.186.