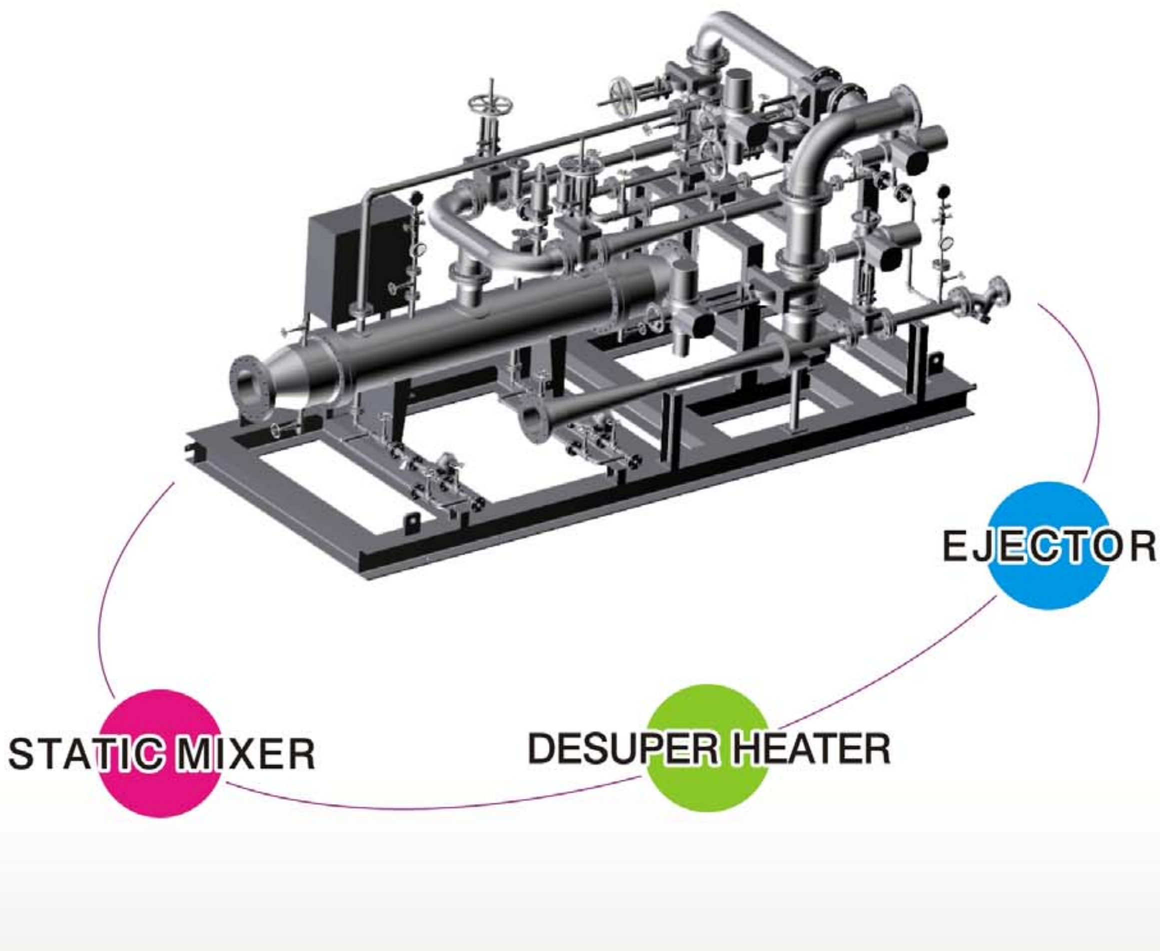
EJECTOR SYSTEM FOR POWER PLANT



SAMWON ENGINEERING CO., LTD.

STEAM JET AIR EJECTOR SYSTEM FOR POWER PLANT

Steam-jet air ejector systems combine ejectors, condensers and interconnecting piping to provide relatively low-cost and low-maintenance vacuum pumping. These systems operate on the ejector-venturi principle, which relies on the momentum of a high-velocity jet of steam to move air and other gases form a condenser connecting pipe or vessel.

The efficiency of steam turbines in a power plant directly correlates to the pressure of the steam that exits the turbine. condenser is typically installed to capture and condense steam exiting the turbine. Steam jet vacuum systems installed at the condenser outlet, efficiently remove non condensable vapors and the associated water vapor from the turbine condenser.

The typical ejector vacuum system designed for power applications is a two-stage, ejector system twin element unit having duplicate ejectors for each stage; one element running and one element on standby. An additional, start – up ejector hogger is normally provided to evacuate the condenser prior to turning

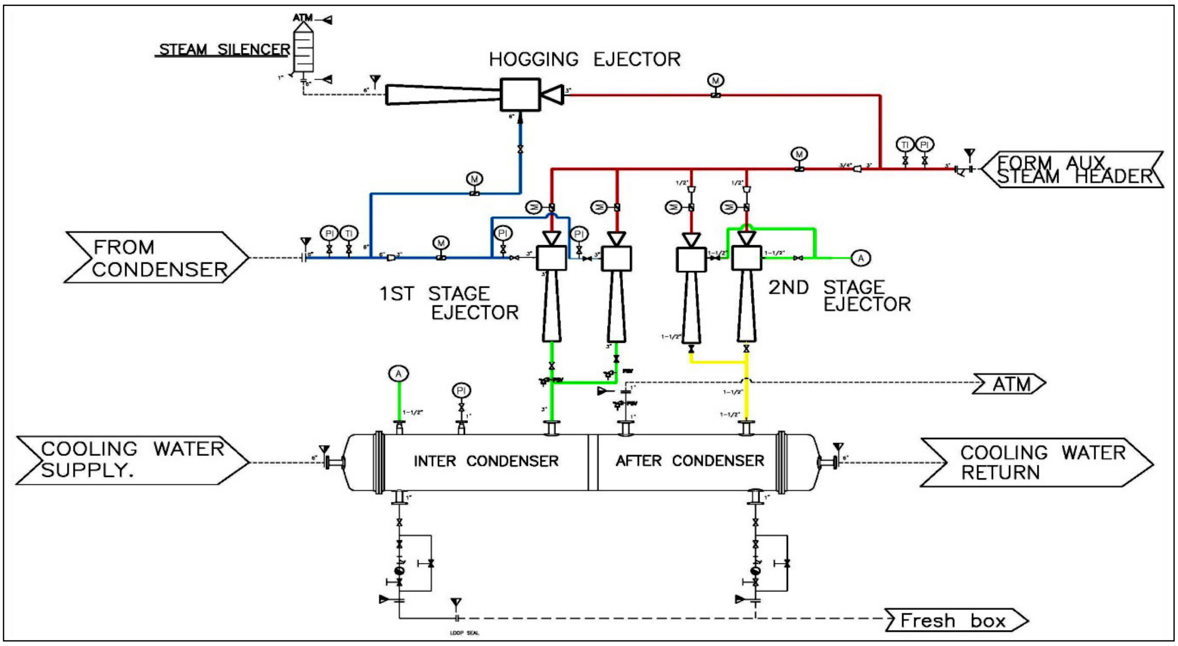
Samwon Engineering can design manufacture the steam jet ejector system. And continues to improve its efficiency and performance. We are the steam jet ejector manufacturer that designs and manufactures all major components of the system.

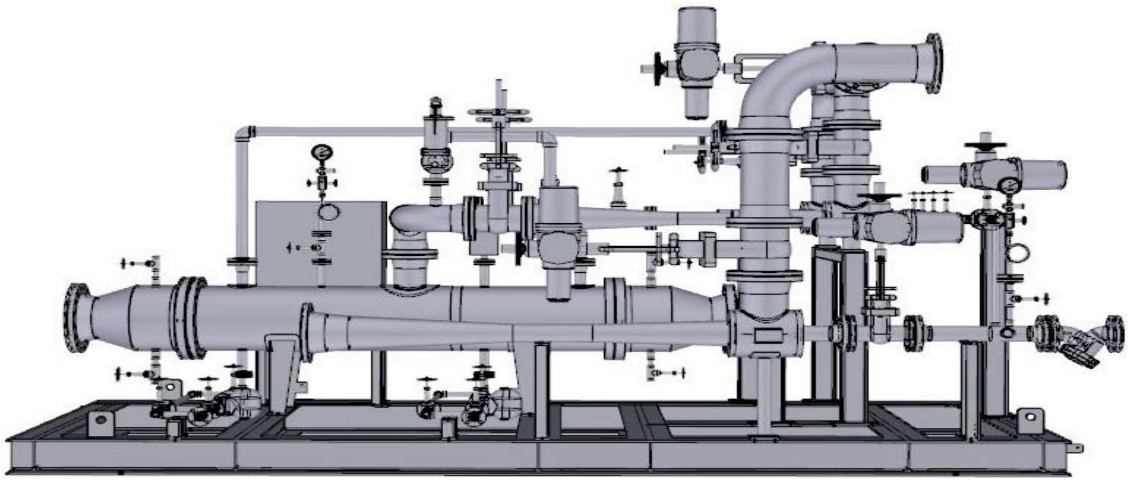
Benefit

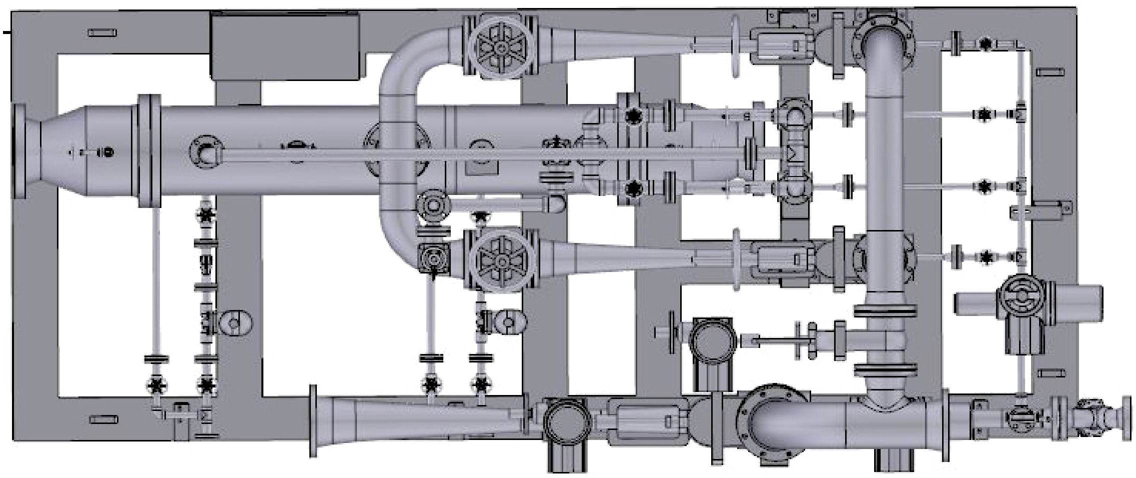
- Ejectors can be operated with many different motive fluids:
  - Steam, air, organic vapor and other gases
- Can handle corrosive and slugging liquids, solid and abrasive suction fluids without damage
- Simple, rugged, reliable and trouble-free.
- No moving parts, no lubrication, no vibration, no bearing or seal problems.
  - Available with flanged or weld end connections.
- Explosion-proof construction.
  - Ejectors can be installed indoors or outdoors with versatile mounting design.
- Low initial cost, low maintenance cost, long life

Ejector System For Power Plant

Typical P&ID of steam jet vacuum system







Technical data

1. Suction capacity(Air extraction of surface condenser)

1) Hogging ejector

The selection of venting equipment to be used with condensers for nuclear power cycles in which additional non-condensible gases are present should be carried out in accordance with section Table #1 with allowance for the quantity of such gases specified

Table #1 RAPID EVACUATION EQUIPMENT CAPACITIES

Total Steam condensed lbs/hour	*SCFM－Dry Air at 10 in Hg A Design Suction Pressure
Up to 100,000	50
100,001 to 250,000	100
25,001 to 250,000	200
500,001 to 500,000	350
1,000,001 to 1,000,000	700
2,000,001 to 2,000,000	1050
3,000,001 to 3,000,000	1400
4,000,001 to 4,000,000	1750
5,000,001 to 5,000,000	2100

Note : in the range of 500,000 lbs/hr steam condensed and above, the above table provides evacuation of the air in the condenser and L.P. turbine from atmospheric pressure to 10in. HgA in about 30 minutes if the volume of condenser and L.P. turbine is assumed to be 26 cu ft/1000 lb/hr of steam condensed.
*SCFM- 14.7 psia at 70℉ － to convert to lbs/hr. multiply above values by 4.5.

2) Holding ejector

Extraction of non-condensables and water vapor from condenser for heat transfer and provide deaeration of condensate.(Table #2)

Table #2 VENTING EQUIPMENT CAPACITIES
A. One Condenser Shell

Effective Steam flow Each Main Exhaust Opening lbs/hr	Total Number of Exhaust Openings								
	1	2	3	4	5	6	7	8	9
50,001 to 100,000 *SCFM	5.0	7.5	10.0	10.0	12.5	12.5	15.0	15.0	15.0
Dry Air lbs/hr	22.5	33.8	45.0	45.0	56.2	56.2	67.5	67.5	67.5
Water Vapor lbs/hr	49.5	74.4	99.0	99.0	123.6	123.6	148.5	148.5	148.5
Total mixture lbs/hr	72.0	108.2	144.0	144.0	179.8	179.8	216.0	216.0	216.0
100,001 to 250,000 *SCFM	7.5	12.5	12.5	15.0	17.5	20.0	20.0	25.0	25.0
Dry Air lbs/hr	33.8	56.2	56.2	67.5	78.7	90.0	90.0	112.5	112.5
Water Vapor lbs/hr	74.4	123.6	123.6	148.5	173.1	198.0	198.0	247.5	247.5
Total mixture lbs/hr	108.2	179.8	179.8	216.0	251.8	288.0	288.0	360.0	360.0
250,001 to 500,000 *SCFM	10.0	15.0	17.5	20.0	25.0	25.0	30.0	30.0	35.0
Dry Air lbs/hr	45.0	67.5	78.7	90.0	112.5	112.5	135.0	135.0	157.5
Water Vapor lbs/hr	99.0	148.5	173.1	198.0	247.5	247.5	297.0	297.0	346.5
Total mixture lbs/hr	144.0	216.0	251.8	288.0	360.0	360.0	432.0	432.0	504.0
500,001 to 1,000,000 *SCFM	12.5	20.0	20.0	25.0	30.0	30.0	35.0	40.0	40.0
Dry Air lbs/hr	56.2	90.0	90.0	112.5	135.0	135.0	157.5	180.0	180.0
Water Vapor lbs/hr	123.6	198.0	198.0	247.5	297.0	297.0	346.5	396.0	396.0
Total mixture lbs/hr	179.8	288.0	288.0	360.0	432.0	432.0	504.0	576.0	576.0
1,000,001 to 2,000,000 *SCFM	15.0	25.0	25.0	30.0	35.0	40.0	40.0	45.0	50.0
Dry Air lbs/hr	67.5	112.5	112.5	135.0	157.5	180.0	180.0	202.5	225.0
Water Vapor lbs/hr	148.5	247.5	247.5	297.0	346.5	396.0	396.0	445.5	495.0
Total mixture lbs/hr	216.0	360.0	360.0	432.0	504.0	576.0	576.0	648.0	720.0

*14.7 psia at 70 ℉
Note: These tables are based on air leakage only and the air vapor mixture at 1 inch HgA and 71.5℉

2. Suction pressure

The design pressure is that for which the condenser is designed minus 1.0inch Hg or the lowest required operating pressure, whichever is lower. Minimum is to be 1.0inch HgA

3. Performance test

These standards cover applicable procedures for factory testing but may also be used for field testing provided the below "field tests" are observed

1) Test items

To test a steam jet ejector adequately, it is necessary to establish the correct values for the items listed below, when the ejector is operating at the design point and at specified steam and water conditions

A. Capacity
B. Suction pressure
C. Total steam consumption

2) Test process

A. Motive side of ejector shall be connected with boiler.
B. Suction side of ejector shall be installed orifice with valve.
C. The orifice shall be machined as nozzle size of paragraph 3.B
D. Open the valve of motive side.
E. Design suction pressure shall be checked as datasheet.
F. then check the actual suction vacuum gauge.

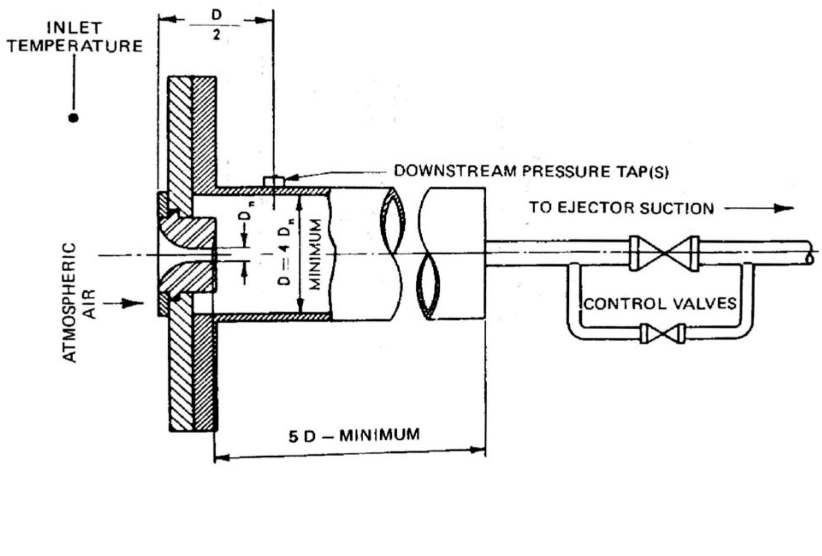
3) Suction load calculation

A. The Suction capacity shall be changed 'DAE' according to HEI 5.3.4 & APPENDIX 3
Entrainment Ratio = weight of gas / weight of air
B. Suction side orifice nozzle size calculation.
Where ;

$$Wa = \frac{1503 \times C \times Dn^2 \times P1}{\sqrt{T1}}$$

Wa = Air flow rate, lb/hr (DAE)
C = Nozzle coefficient
Dn = Diameter of nozzle throat for orifice at suction nozzle(only used for shop test), inch
P1 = Upstream static pressure, psia
T1 = Upstream temperature, °F absolute

Figure 1. Arrangement of flow nozzle for subcritical air flow tests



4) Field tests

Where it is possible, the ejector components should be isolated from the process or any adjacent equipment to conduct field performance tests

The preferred method of isolation of the ejector or ejector components shall be the use of a gasketed flange or blank off plate between the process or system and equipment to be tested.

Other means of isolation will be acceptable if it is proven by test to be leak free. Some alternative means of isolation could involve valves or temporary closures.

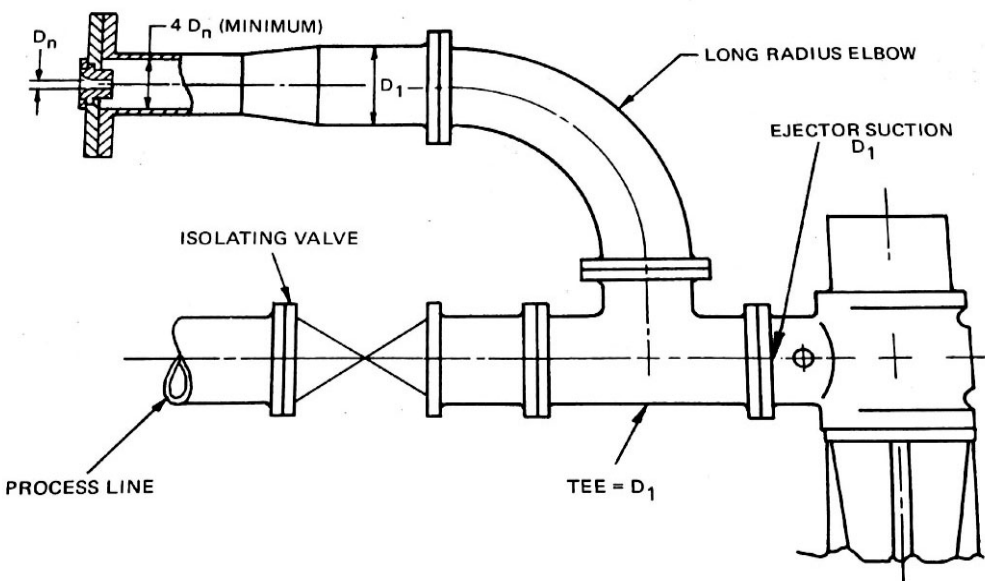
Provisions should be made between isolation devices and the ejector system for introduction of test loads. All possible precautions should be taken to insure adequate diffusion of the load gas and to locate pressure taps where they will not be subject to velocity effects from the load and, therefore, indicate static pressure.

The loads for field testing shall not be generated by the system unless flows can be measured directly ahead of the ejector. If the system gases are used, the components and properties must be verified.

Preferred alternate load arrangement is shown in Fig 2. Other arrangements may be used upon mutual agreement.

Provisions should be made so that the ejector or ejector components discharge pressure does not exceed design conditions.

Figure 2. Alternate loading arrangement for field testing



Ejector System For Power Plant

Products

GE3 Project(60 MW)	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Gusan City, Korea
Capacity	: 65.3 kg/hr air & water vapor
Suction P	: 0.065 kg/cm2 a
Discharge P	: 1.07 kg/cm2 a
Material	: A106(Steam chest, Body), A276 TP304(Jet nozzle), A105(Diffuser)

RAS DJINET CCPP Project(1131.1 MW)	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Alger, Algeria
Capacity	: 81.6 kg/hr air & water vapor
Suction P	: 0.034 bar a
Discharge P	: 1.07 bar a
Material	: A106(Steam chest, Body), A276 TP304(Jet nozzle), A516(Diffuser)

UCH II EXPANSION Project(136.9 MW)	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Pakistan
Capacity	: 98 kg/hr air & water vapor
Suction P	: 0.034 bar a
Discharge P	: 1.07 bar a
Material	: A106(Steam chest, Body), A276 TP304(Jet nozzle), A516(Diffuser)

Ejector System For Power Plant

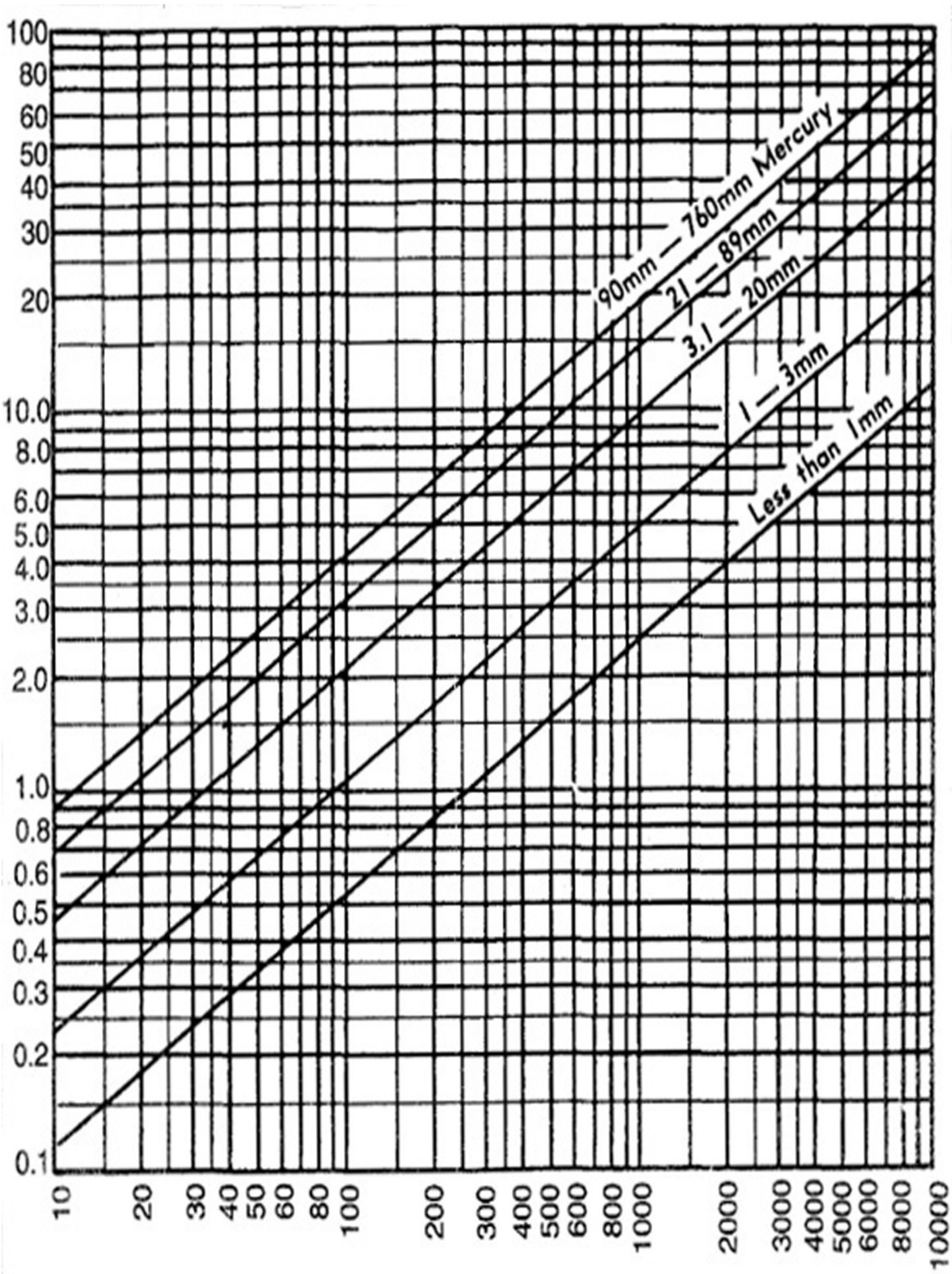
Products

Gimcheon Combined Heat and Power Plant(60 MW)	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Kimcheon, Korea
Capacity	: 65.3 kg/hr air & water vapor
Suction P	: 0.08 bar a
Discharge P	: 1.07 bar a
Material	: A106(Steam chest, Body), A276 TP304(Jet nozzle), A105(Diffuser)

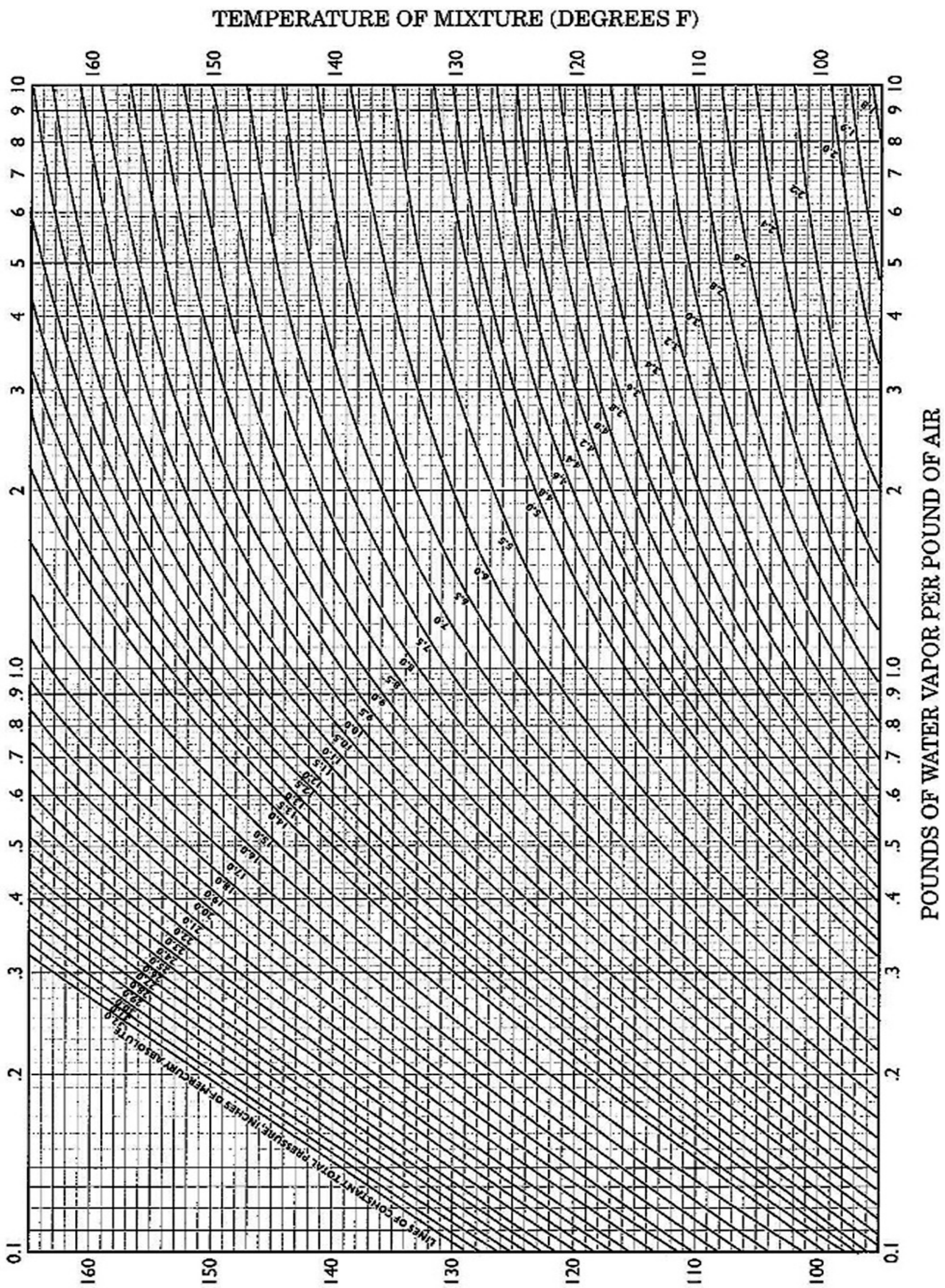
KIRIKKALE IPP	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Kirikkale Province, Turkey
Capacity	: 98 kg/hr air & water vapor
Suction P	: 0.034 bar G
Discharge P	: 1.06 bar G
Material	: A106(Steam chest, Body), A479 TP316(Jet nozzle), A516(Diffuser)

Therma Visayas Energy Project	
Two stage, condensing type with shell and tube intercondenser and aftercondenser	
Location	: Toledo City, Philippines
Capacity	: 81.6 kg/hr air & water vapor
Suction P	: 25.4 mmHg
Discharge P	: 800 mmHg
Material	: A106(Steam chest, Body), A276 TP316(Jet nozzle), A516(Diffuser)

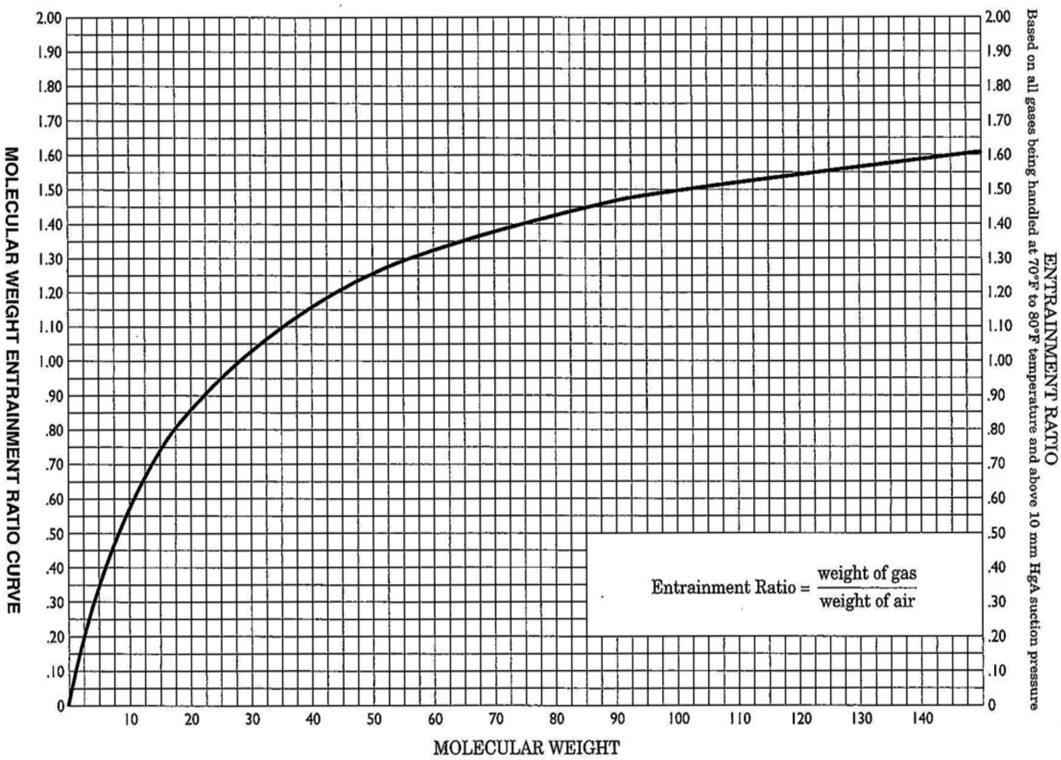
APPENDIX 1. System volume - cubic feet maximum air leakage values for commercially



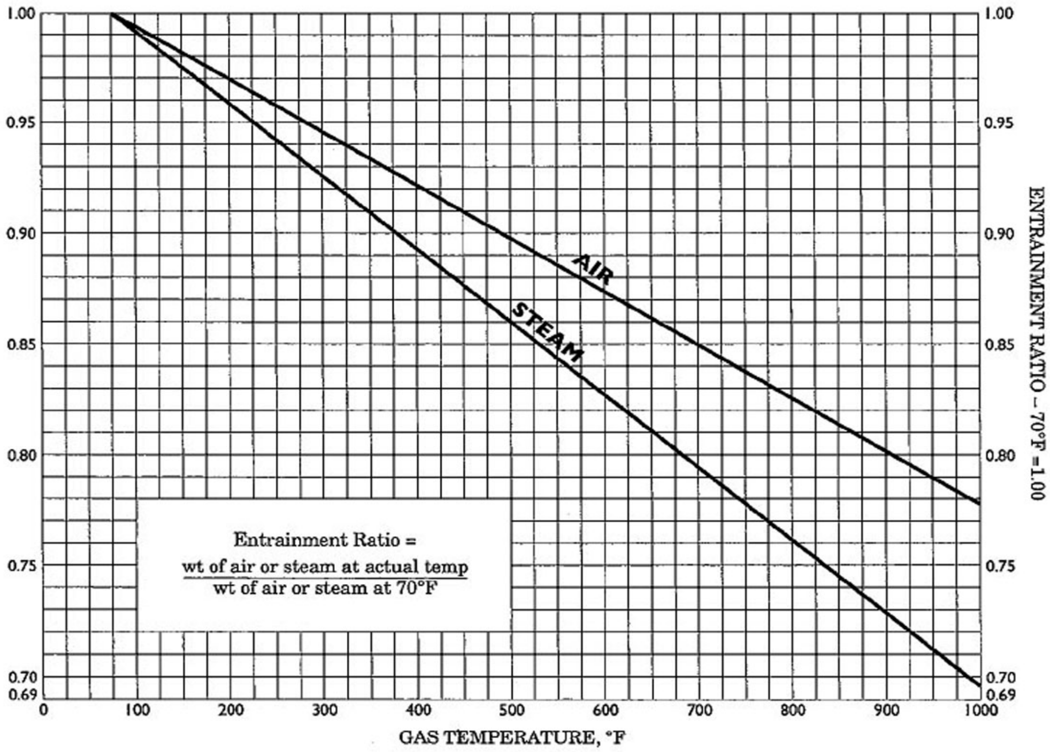
APPENDIX 2. Air and water mixture data(Dalton's law)



APPENDIX 3. Mol w.t. entrainment ratio curve.



APPENDIX 4. Temperature entrainment ratio curve



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