SIAM COMPRESSOR
INDUSTRY CO., LTD.

Vapor-injection technique Development Guideline

1. Introduction

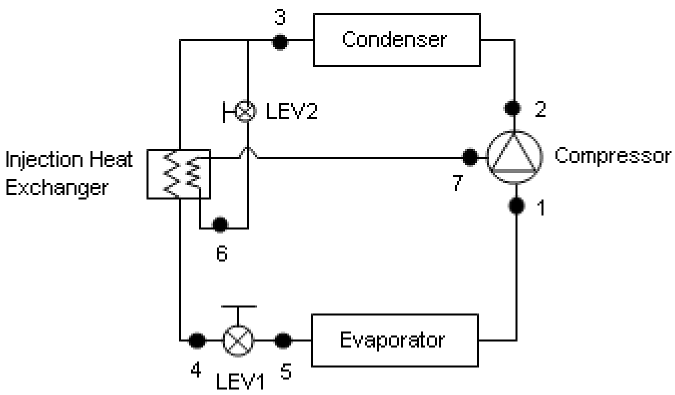
This guideline shows the advantage and characteristics of Mitsubishi vapor injected-scroll compressor. The vapor injected-scroll compressor can help customer increasing the heating capacity and heating COP value with smaller size of the compressor for low ambient application.

2. Injection Schematic

The Injection system has 2 additional parts which is injection heat exchanger and electronic expansion valve (LEV2)

2.1) Injection Heat Exchanger is used to provide additional subcooling which help increasing heating capacity of the system.

2.2) Electronic Expansion Valve (LEV2) is used to control the amount of evaporated refrigerant that flow to the compressor. Eventhough, this injection would need more input power of the compressor, but the heating capacity would increase even higher enough to make input power cost nothing. Consequently, the total efficiency of the injection system is still increasing.



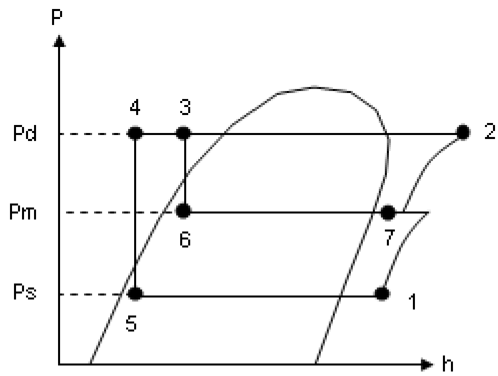


Figure 1: Schematic of internal heat exchanger vapor-injection cycle

State 1: Suction Pressure
State 2: Discharge Pressure
State 3: Subcooled refrigerant leaving the condenser.
State 4: Subcooled refrigerant leaving the injection heat exchanger of main circuit.
State 5: Refrigerant from the injection heat exchanger is expanded by LEV1.
State 6: Refrigerant from the condenser is expanded by LEV2.
State 7: Saturated vapor inject to compressor.

3. Vapor Injected Scroll Compressor

Mitsubishi vapor injected-scroll compressor is DC-inverter, which compatible with R410A. The heating capacity range between 1.6-49.4 kW.

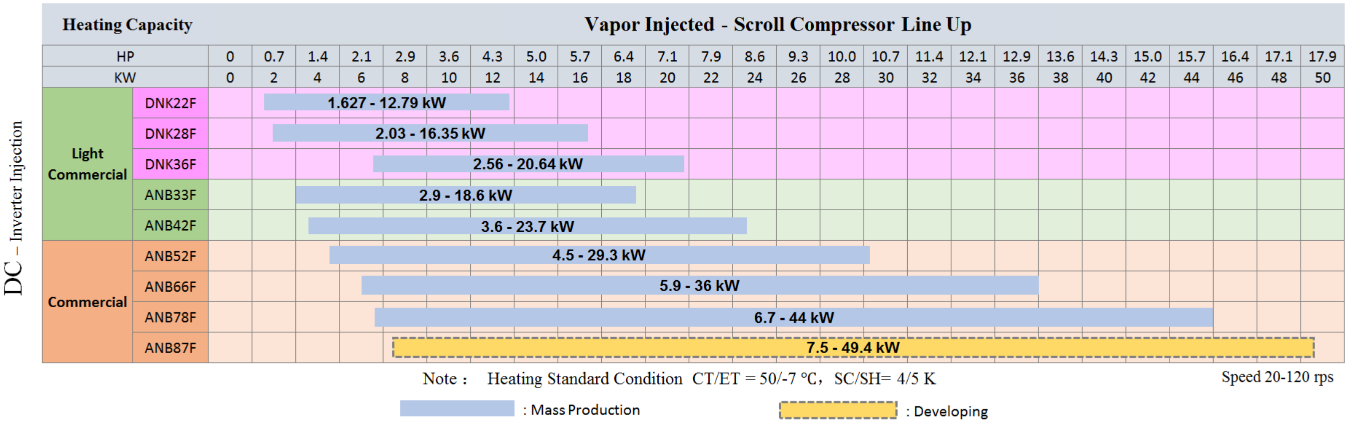


Figure 2: Vapor Injected - Scroll Compressor Line Up

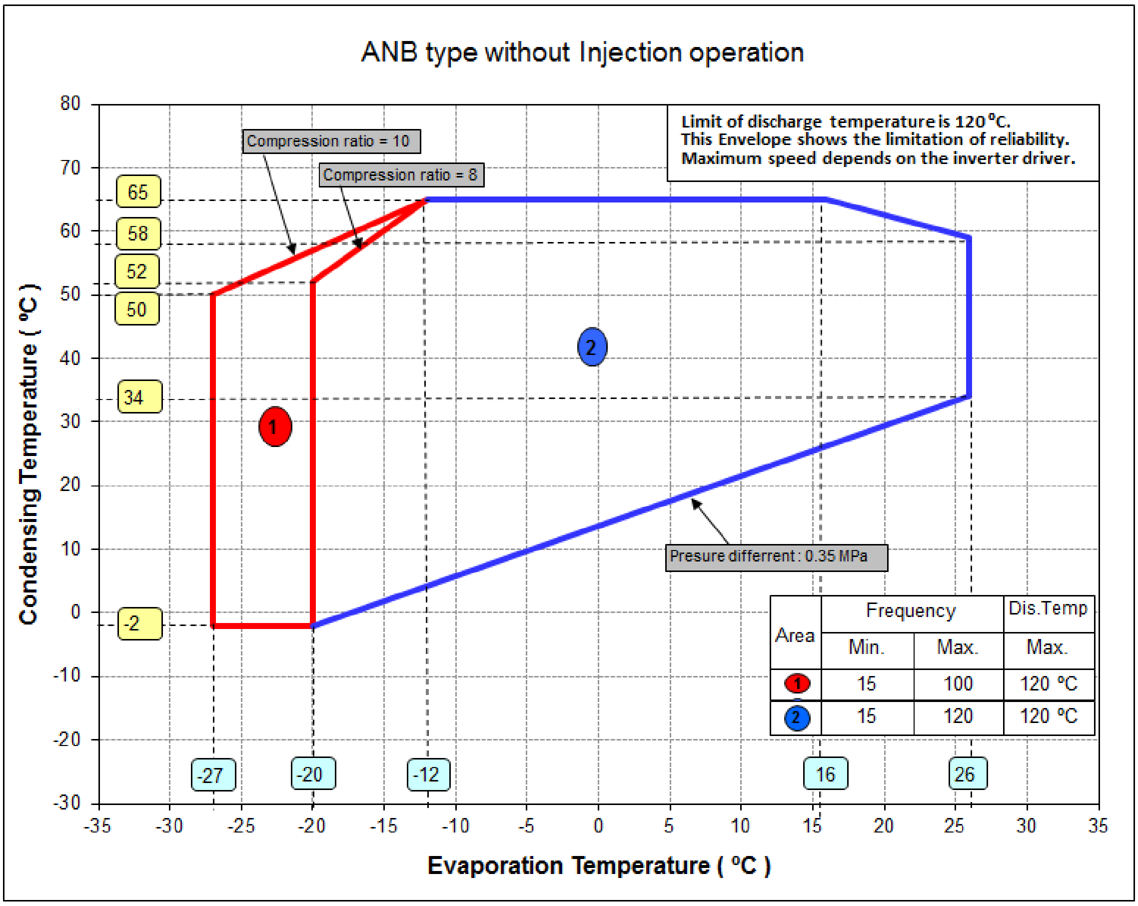


Figure 3: Example of ANB Type Operating Envelop without injection

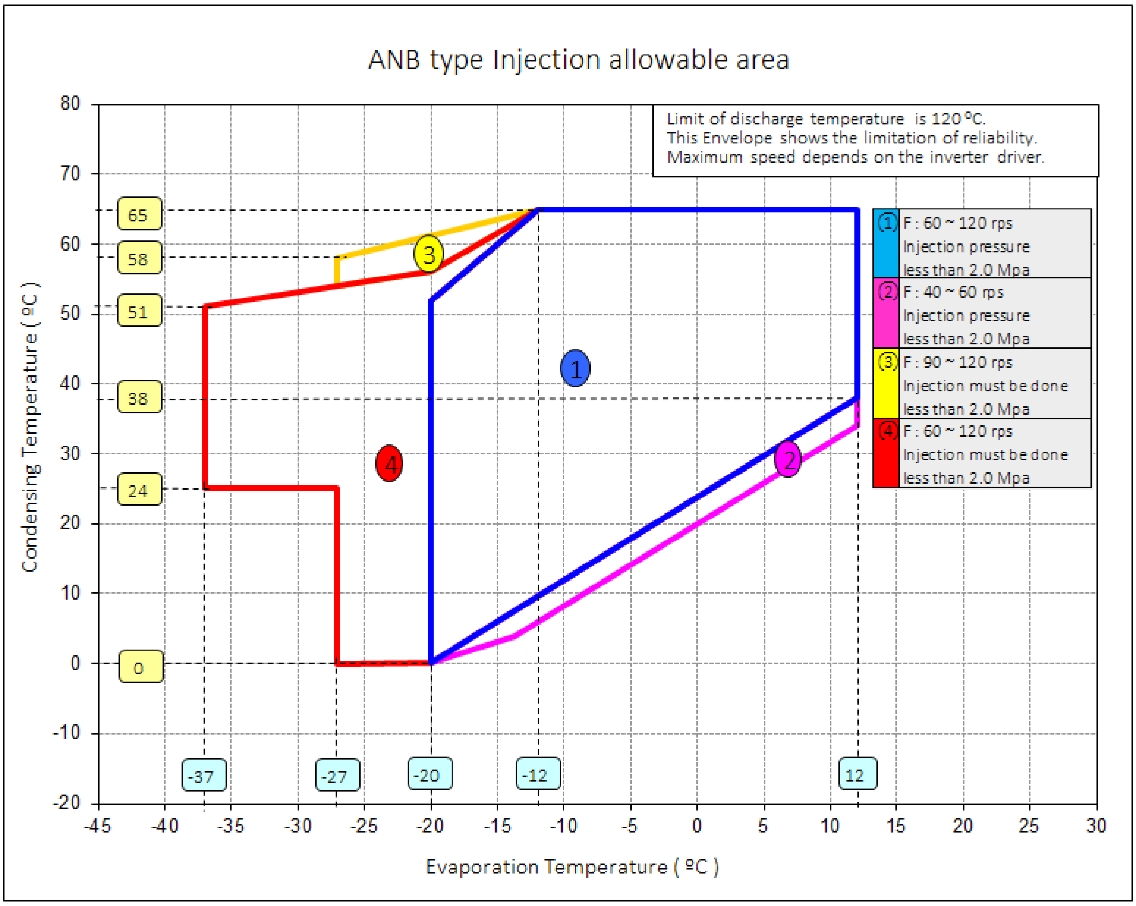


Figure 4: Example of ANB Type Operating Envelop with Injection

Remark: Different compressor model may have different operating envelop. Please check operating envelop of desired model of compressor again.

Vapor injected-scroll compressor (figure 4) has operating envelop bigger than standard compressor (figure 3) which can make CT at 51ºC and ET at -37ºC As a result, this advantage is suitable for heating application which able to make hot temperature in very low ambient temperature.

4. Injection Heat Exchanger

4.1) Heat exchanger capacity size

Heat exchanger capacity size can be calculated by equation (1). It uses 3 value which are Pm (pressure at state 7, figure 1) and Injection flow which located in compressor performance data. The last value is enthalpy between state 6 and state 7(figure 1). Consequently, the Injection Heat Exchanger capacity value air calculated by using the following equation.

*Heat Exchanger Capacity (kW) = Injection Flow * (Enthalpy7 – Enthalpy6)* **(1)**

The estimation of Injection Heat Exchanger capacity shall be 20-40% of heating capacity at minimum operating ambient temperature.

4.2) Flow direction

The best flowing direction for subcooling is counter flow. From figure 1, the refrigerant from state 3 to state 4 counter flows with the other one from state 6 to state 7.

4.3) Design condition

The best design condition for customer depends on the minimum ambient temperature of unit operation where the COP improvement of injection system given the highest value.

For example (from figure 5), if the minimum ambient temperature for operate the unit of Sweden is -20 °C. The injection heat exchanger should be designed by using this ambient temperature which would give the best efficiency of the injection system. The best time to start operating injection system when ambient temperature is lower than 7°C .

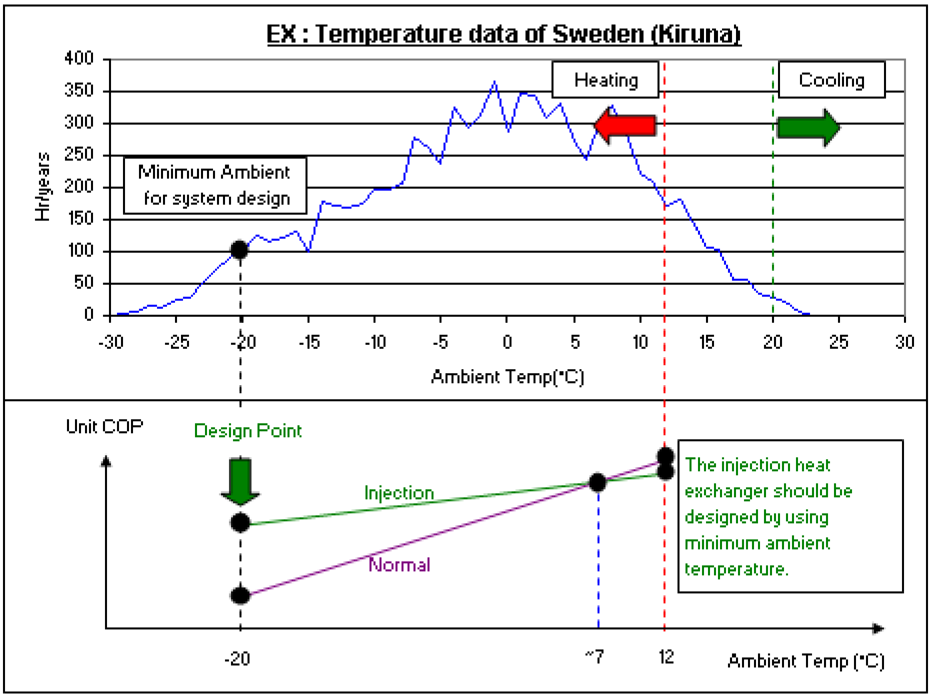


Figure 5: Example of injection heat exchanger value selection

5. Injection Expansion Valve Control and Main Expansion Valve Control

5.1) Starting up period

LEV1 should be controlled by suction superheat until discharge superheat [DSH] value over than DSH setting point value. After that, LEV1 would be controlled by DSH value.

LEV2 should be closed until DSH value over than 10K.

5.2) Working period

To get highest COP value of system,

LEV1 should keep DSH value to be follow for DSH control guideline for improve.

LEV2 should keep injection superheat value to be in between 1 to 5 K

Control system operation follow compressor envelop.

5.3) Stop period

LEV2 should be closed to stop injection before compressor stops

6. Compressor Protection

6.1) Motor overheated protection

Discharge temperature should be lower than 120 ^{o}C to protect motor overheated.

The position of sensor should be on the top shell of compressor or at the surface of heat insulated discharge pipe at 120 mm distance from the shell surface

6.2) Minimum oil level in compressor

The oil level in compressor should checked by using sight glass of compressor. It has always to be higher than the limit of each compressor's specification.

For example:

Scroll A-Series: Minimum oil level limit =300 cc

Scroll D-Series: Minimum oil level limit =300 cc

6.3) Liquid flow back protection

6.3.1 Customer must check for Discharge Superheat (DSH) temperature to be more than 10K.

DSH = Discharge temperature– Saturated temperature of discharge pressure

6.3.2 Injection circuit should be open after the system has been superheated to protect liquid refrigerant flow back into compressor. For Inverter model, the injection circuit should be opened as compressor speed which is defined in compressor operating envelop with injection.

6.3.3 LEV2 must be closed before compressor stop to protect liquid refrigerant flowing back into the compressor.

6.4) High pressure protection

6.4.1 Injection pressure protection.

Injection pressure must be lower than 2.0 MPaG. While the system must be installed the protection device.

6.4.2 Condensing pressure protection.

Discharge pressure must be lower than 4.15 MPaG. While the system must be installed the protection device.

6.5) Compressor operation control

Compressor must be operated within compressor operating envelop. Operating pressure, rotational speed, and discharge temperature must be control as define in compressor operating envelop.

6.6) Further more details

Please see detail in individual specification and general specification of each model.