

Pilot Operated Relief Valve Hydraulic Requirements

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Introduction

Although the general impression is that pilot operated relief valves are independent of system hydraulic, however most of the time they are the ones which need more time and attention during design and procurement because of the services (low pressure systems) in which they are usually utilized.

This notes reviews different types of pilot operated relief valves and hydraulic requirement of each type.

Hydraulic Calculation

As shown in Figures 1 to 4, pilot operated relief valves are either pop or modulating action, equipped with flowing or non-flowing pilot system and provided with remote or internal pressure sensing element.

1. Pilot tube tapping can be taken from pressure source (remote sensing) or relief valve inlet nozzle (internal sensing).

- For remote sensing arrangement, relief valve inlet line pressure drop can be higher than 3% provided pilot tube pressure drop is limited to vendor requirement. This means relief valve opens and closes sharply at set values because protected equipment pressure is precisely detected by pilot. However relief valve capacity is likely to reduce below required relief rate if inlet line pressure drop is excessive. Relief valve manufacturer can advise the actual valve capacity according to exact pressure at relief valve inlet nozzle. The same can be estimated by designer through relief valve sizing equation in API-520 (finding the lowest relieving pressure at which relief valve can pass required flow).

- For internal sensing arrangement, since the length of pilot tube is short and can be managed by vendor to get desired function then pressure drop of pilot line does not need to be checked by designer. Relief valve inlet line pressure drop should be limited to 3% of set pressure as this type of relief valve does not have any privilege over conventional type with respect to inlet pressure loss criteria.

2. Pilot operated relief valve can be equipped with flowing or non-flowing pilot.

- Flowing type allows process fluid to continuously flow through the pilot when the relief valve is open, therefore the pressure drop through pilot tube should not be excessive. Since flow rate through flowing type is not known by designer, pilot tube sizing shall be done in close coordination with relief vendor.
- Non-flowing type measures the static pressure of system at the tapping point therefore pilot tube pressure drop is negligible and does not need to be checked by designer.

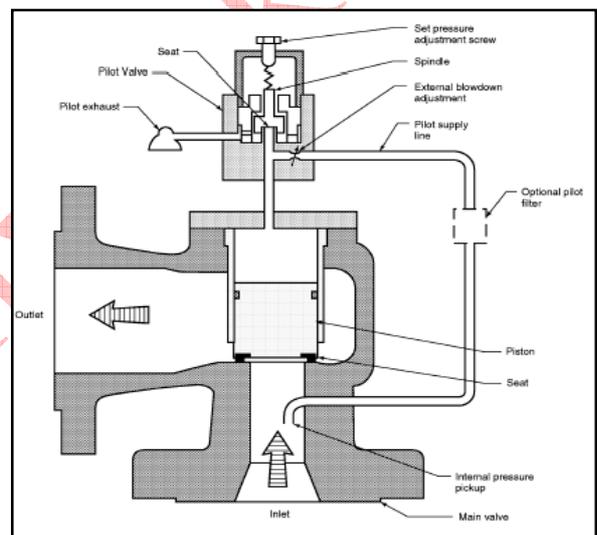


Figure 1 - Pop action flowing type pilot

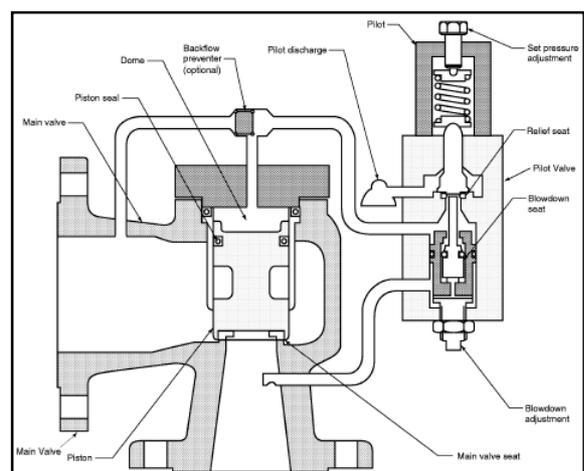


Figure 2 - Pop action non-flowing type pilot

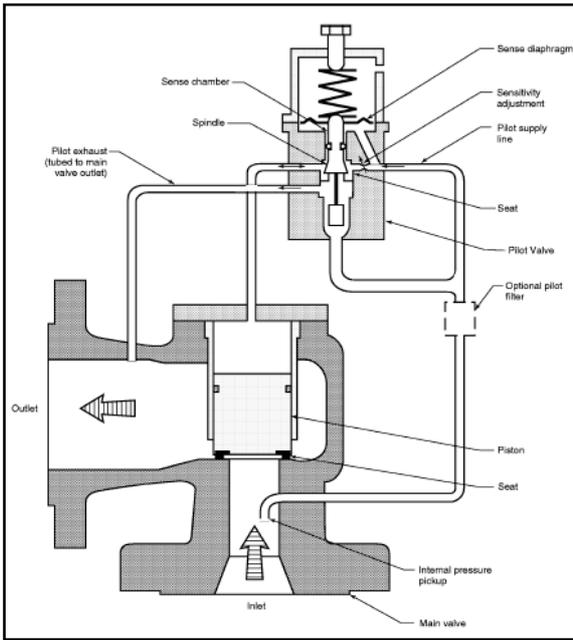


Figure 3 - Modulating action flowing type pilot

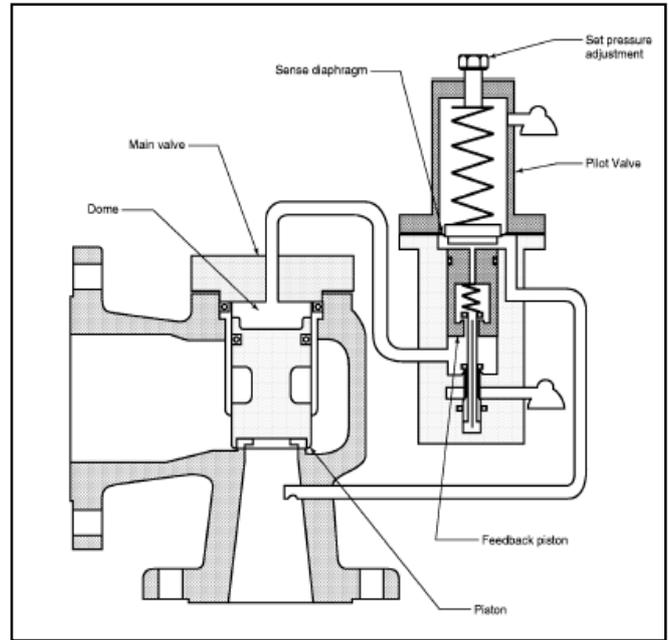


Figure 4 - Modulating action non-flowing type pilot

3. Pilot operated relief valve can be pop action or modulating action valve. For pop action pilot operated relief valve inlet line hydraulic is done based on the actual (rated) capacity of the valve whereas required relief rate is used for modulating type.

Conclusion

Above paragraph can be summarized in below table.

Sensing Element Type	Pilot Type	Relief Valve Inlet Line Loss	Pilot Line Loss
Internal	Flowing	To be limited to 3% of relief valve set pressure	No need to be checked by designer. It can be managed by vendor as it is part of his design and supply scope
	Non-flowing		
Remote	Flowing	No limit as long as valve capacity is not reduced below required value*	To be sized according to vendor requirement
	Non-flowing		Technically no limit unless specified by vendor

*Inlet line loss can be important if pilot tapping is taken from inlet line (It is generally recommended to locate the pilot tapping on the no/low velocity point).

In view of above, it seems that only non-flowing pilot operated relief valve with remote sensing can be properly designed with least interactions with vendor. However I strongly recommend performing this exercise jointly with relief valve vendor especially for low pressure systems (such as atmospheric tanks). I have seen a case where adding one additional elbow on pilot tube was not acceptable to vendor.

Contact

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