DEVELOPMENT OF NONINTERCHANGEABLE SUCTION AND DISCHARGE VALVES

R. M. Deminski
The Cooper-Bessemer Corp.
Mount Vernon, Ohio

In recent years the safety requirements in process plants, and mechanical and chemical complexes in general, have become appreciably more stringent. These safety requirements have now grown to include the reciprocating compression equipment to such an extent that industry wide safety specifications are now coming into existence. One such code that will shortly come into existence is covered by the American Petroleum Institute. The American Petroleum Institute or A.P.I. has devoted one section of this code specifically to the problems that can possibly be experienced with valves as a result of suction and discharge valve interchangeability. There are many reasons for the generation of this code, and, in more recent years, the validity of these reasons has become more obvious.

Need for inherently safe components

The increase in number of operations involving reciprocating compressors has been very rapid in recent years. Along with this increase there has been a reported shortage of qualified operating and maintenance people. These two factors, in combination with each other, have automatically resulted in certain hazards, basically because of the unfamiliarity with the equipment. Along with this goes the situation of more complicated systems as the equipment in question is automated to higher degrees. Automation has naturally reduced the number of people necessary to operate and maintain this equipment and, in fact, in some areas, has reduced the necessity of having highly skilled maintenance people on the job. For this reason, and the other reasons previously mentioned, it becomes necessary to have components that are inherently safe. That is to say, one would be using equipment that removed, to the greatest practical degree, the possibility of failure as a result of human error. Although the number of failures that are directly attributable to improper valve installations are relatively few in number, the failures have been quite significant in magnitude. In fact, on one or two occasions, fatalities have been experienced along with the mechanical failure. Considering the reasons for the need for noninterchangeable valves, and even in light of failures that have occurred, it is interesting to note that the A.P.I. specifications do not require the noninterchangeability feature to be applied to all installations of reciprocating compressors. They rather state that noninterchangeable valves shall be supplied when specified by a customer. There can be no argument that noninterchangeable valves eliminate one potential source of trouble, but, on the other hand, it does present other problems to the compressor builder and to the compressor user.

Past compressor requirements

The fact that all valves supplied today do not have the feature of noninterchangeability is explained by the requirements that have been stipulated by compressor users in years past. There have been many customers who had as a requirement the complete interchangeability of suction and discharge valves. The reason for this requirement was the reduction in the number of parts necessary for maintaining a reasonable number of spares for a given piece of equipment. It allowed the customer to have greater flexibility of the compressor cylinder and his piping system since a cylinder could be changed from top suction to bottom suction simply by the shifting of valve locations. The customer was further able to obtain his valve parts at a lower cost because of the simpler design that was permitted through the use of interchangeable valves.

The features that make noninterchangeable valves somewhat undesirable should be rather obvious in that they are simply the opposite of the features that make interchangeable valves desirable. A compressor cylinder, with noninterchangeable valves, is suitable only for a given type operation. If it is desired to change the location of a suction connection on a given cylinder, after it has been manufactured, it is necessary to either remachine the existing cylinder or replace it with a cylinder that has its valve properly oriented. It is obvious that this situation presents the possibility of manufacturing errors to the compressor builder. This should be generally of no concern to the compressor user except as such errors may cause late delivery. Obviously, the number of items that must be kept in stores both by the builder and the user, for valve replacements, must be increased.

Shape or features of valve pockets

The type of noninterchangeable valve protection that will be employed will depend upon the shape or features of the suction and discharge valve pockets. It would be a pretty safe assumption that cylinders now in production and those in the field are generally equipped with suction and discharge valve pockets that are identical. In this situation, and unless remachining is done to the valve pockets, the only approach to the valve problem is a system of dowels. In this arrangement it

is necessary to drill valve seats, guards, cages, caps, and cylinder bodies for the installation of pins or dowels. This must be done on all pockets if complete noninterchangeability is to be attained.

One approach that has been used involves at least two dowels in these items in both the suction and discharge valve assemblies. In one assembly the dowels may be located 180° apart, while in the other assembly they will be located at any other included angle, other than the 180° spacing. As long as these dowels remain in place, one can be well assured that the proper valve assembly will be located in the proper pocket. The obvious problems with this arrangement is the fact that a dowel is simply force or drive fit into the components of the assembly. As such, it is subject to machining tolerances and a possible loose assembly which may result in a loss of dowels.

Spring loaded dowels

If a dowel for any reason should work loose from the assembly, then the safety feature is lost. For this reason, roll pins should be employed. These pins are effectively a spring loaded dowel, which give greater assurance of the dowel or pin remaining tight in the item to which it was assembled. Inasmuch as these items are rather readily assembled with the tap of a small hammer, they are also readily removed with a pair of pliers. One is then relying on the integrity of the operator or maintenance people not to remove these dowels when spare parts become short. With this arrangement of dowels, and the dowel remaining intact, it is impossible, through the manipulation of any parts involved, to assemble a suction valve in a discharge pocket or a discharge valve in a suction pocket. Even in the event that improper assemblies are ordered for these cylinders, assemblies which do not have the pins installed, it will be impossible to assemble them to the protected cylinder. This is true only when the valve cap to cylinder body dowel is located in the cylinder body.

In a situation where noninterchangeable valves are specified on an order, the cylinder body will be manufactured with dissimilar dimensions in the suction and discharge pockets. Quite naturally the seats and guards from suction to the discharge side will have comparable changes in dimensions which will then make them 100% noninterchangeable. With this arrangement, it will be impossible to interchange valves without completely remachining the seats and guards involved. In fact, the suction valves cannot be remachined in any manner to be used in a discharge valve pocket. This arrangement is the one that should be employed when noninterchangeable valves are specified as original equipment. This system is designated as complete noninterchangeability.

Limited noninterchangeability

There can be another form of noninterchangeability which affects the suction valve only. In this situation all the components of the suction valve assembly are larger in diameter than those of the discharge valve assembly. With this arrangement it would be possible to assemble a discharge valve in a suction pocket, but never a suction valve to the discharge pocket. With a full complement of discharge valves in a cylinder, it is only possible to pull a partial vacuum, but never possible to attain the extreme pressures that result from the installation of a full complement of suction valves. For all practical purposes, the limited noninterchangeability design is every bit as safe as the complete noninterchangeable arrangement, but it does allow for a loss of time when improper assemblies are made. These improper assemblies, however, are not the least bit hazardous.

If a compressor user was to specify that the noninterchangeable valve feature be supplied with his equipment, then he should probably include, as an added feature, the containment of all valve elements. The latter requirement relates most specifically to the suction valve assembly, where failures of a valve bolt may cause the guard and/or broken portion of the bolt to fall into the cylinder. Provisions against such accidents can be readily adapted to the valve assembly, on original equipment, at the same time that the valve is being designed for the noninterchangeable feature. In fact, the feature of containment of these parts aids in the assurance of the noninterchangeable feature. These two features combined, guard the valve against the possibility of being a contributor to, or cause of, an accident of any magnitude.

DISCUSSION

JONES—Canadian Industries Ltd.: I'm afraid I don't know very much about the design but the point occurs to me—what sort of flexibility do you have—are you able to substitute channel valves with plate valves or double-deck valves, with single-deck valves, and so on, using this, or do you get the design dead right the first time?

DEMINSKI: Well, in our revamp of both valves, we considered the possible variations of valves, including the channel, plate, double-deck, and any one of these assemblies of the suction valve assembly. Whether it be double-deck or channel type, it fits in the same pocket as those of the standard plate. So we have not made it impossible to change valve designs just because of a change in a valve pocket.

BABCOCK—Borden Chemical Co.: We didn't have an incident in reversing the valves in suction to discharge but we did have an incident of a very minor nature where one valve was put in upside down on the discharge side. Fortunately, there was more than one valve in that cylinder and we found out about it, but it scared us pretty much. I'd like to ask Mr. Deminski if this new noninterchangeable system, he has, prevents putting valves in upside down as well as discharge to suction?

DEMINSKI: The way our valves are presently designed it is possible to make the suction or discharge valve assembly out of any one given seat and guard combination. In other words, what you say is very true. Simply by turning the valve assembly over you have the other hard valve because with any valve assembly, whether it be suction or discharge, there's only one direction the gas can pass through the valve.

As I pointed out before, it was a requirement of earlier customers, basically in the gas transmission field, that the number of spares be cut to a minimum. Because gas transmissions service involves larger cylinders, there is more than one suction and one discharge valve per end, so that the possibility of getting a complete assembly, say, of suction valves on one given cylinder end, takes considerable effort on the

part of most anyone who is putting them in. However, when we start working on the higher pressure cylinders where you generally have one suction and one discharge per end, your chances become increasingly greater to make this error and to let it go unnoticed until you start up the machine. Maybe I haven't given an answer to your question specifically as yet, there are so many implications to this problem.

BABCOCK: I gather your answer is it can be done but it is pretty difficult to do.

DEMINSKI: Well, the way we are going at it now, we are altering the discharge valve pockets, so that when the suction valve components are assembled into a discharge pocket, you can't even start the nuts onto the studs for the valve caps. Now the seats for the suction and the discharge valve are completely different. The guards are completely different, but the cages and caps remain the same. The interchanging of caps and cages, of course, poses no problem.

WALTON—Sun Olin: Mr. Deminski, I'm not clear in my own mind where you and the present manufacturing industry stand on this. Are you saying that you'll provide noninterchangeable valves if the customer requests it in the original order, or are you, as a matter of principle, changing your design so that this is all that you will supply on the new orders?

DEMINSKI: Probably there's a two part answer to the question. One, where we have the existing designs of compressor cylinders and where the customer does not specify a noninterchangeable valve, we will supply our existing standard type cylinders, which means interchangeable valves. On new designs we are accomplishing both the noninterchangeability features and the retainment of the suction valve parts, if they break, from dropping into the cylinder. We have, on some of our existing equipment, already supplied compressor cylinders, specifically in oxygen service, equipped in this manner. The first ones we ever built went into oxygen service. This was basically a requirement of people who had experienced fires and/or explosions in oxygen machinery.