A method is provided for installing a valve seat in the hole of a valve element. The valve seat is fabricated from a seal material having a freezing temperature. The seal material is stretched such that a portion thereof has a reduced diameter that is less than the diameter of the valve element’s hole. The stretched portion of the seal material is immersed in a first environment having a temperature that is less than the freezing temperature of the seal material to thereby freeze the stretched portion and fix its reduced diameter. The stretched and frozen portion is then placed in the valve element’s hole with the combination then being placed in a second environment having a temperature that is greater than the freezing temperature of the seal material.

20 Claims, 3 Drawing Sheets
FIG. 1

STRETCHING APPARATUS

CUTTING TOOL(S)

FREEZING ENVIRONMENT
COLD INSTALLATION OF ELASTOMERIC VALVE SEAT

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to installing a valve seat. More specifically, the invention is method for the cold installation of an elastomeric valve seat in a valve element.

2. Description of the Related Art

Conventional elastomeric valve seat installation methods result in inconsistent seat material stresses. Typically, such installations utilize a plug or puck of elastomeric seat material that is placed or pressed into a hollow cavity of a valve element. The outer edges of that cavity are then swaged over to constrain the plug/puck. A variety of tools and method have been employed in attempts to load the plug/puck evenly and provide positive restraint. However, the results have been mixed. Sometimes the swaging process is too loose and the plug/puck is rejected under high differential pressure. Other times the swage is too tight causing cuts in the seal material or non-uniform stresses in the seal material thereby negatively impacting the integrity of the seal that is to be provided by the seal material.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a method of installing a valve seat.

Another object of the present invention is to provide a method of installing an elastomeric valve seat that results in self-retained and uniformly stressed valve seat.

Other objects and advantages of the present invention will become more obvious hereinafter in the specification and drawings.

In accordance with the present invention, a method is provided for installing a valve seat in a valve element having a hole defined in a surface of the valve element. The valve seat is fabricated from a seal material having a freezing temperature. The seal material is stretched such that a portion thereof has a reduced diameter that is less than the diameter of the valve element's hole. The stretched portion of the seal material is immersed in a first environment having a temperature that is less than the freezing temperature of the seal material. As a result of such immersion, the reduced diameter of the stretched portion is fixed in the first environment. The stretched and frozen portion is then placed in the valve element's hole with the combination then being placed in a second environment having a temperature that is greater than the freezing temperature of the seal material.

BRIEF DESCRIPTION OF THE DRAWING(S)

Other objects, features and advantages of the present invention will become apparent upon reference to the following description of the preferred embodiments and to the drawings, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

FIG. 1 is a schematic view of the materials and tools used to carry out a method of installing a valve seat in accordance with an embodiment of the present invention;
FIG. 2 is a schematic view of the stretching apparatus with the elongate piece of seal material held and stretched thereby;
FIG. 3 is a schematic view of the stretched seal material, the valve element, and the cutting tool(s) immersed in a freezing environment in accordance with an embodiment of the present invention;
FIG. 4A is a cross-sectional view of the valve element with a portion of the frozen seal material installed therein in the freezing environment in accordance with an embodiment of the present invention;
FIG. 4B is a cross-sectional view of the valve element immediately after a portion of the frozen seal material has been installed therein in an environment whose temperature is warmer than that of the seal material's freezing temperature in accordance with another embodiment of the present invention; and
FIG. 5 is a cross-sectional view of the valve element with the seal material expanded to fully fill the hole in the valve element and trimmed even with the surface of the valve element.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring now to the drawings and more particularly to FIG. 1, the work pieces and tools used to carry out a method of installing a valve seat in accordance with the present invention are illustrated schematically. The work pieces include a valve element 10 and a piece of seal material 20. The tools include a stretching apparatus 30, one or more cutting tools 40, and a freezing environment 50. Examples of the various work pieces and tools will be provided in the description to follow. However, it is to be understood that the method of the present invention is not limited to the specific examples.

Valve element 10 is typically a rigid structure (e.g., metal) that forms a moving or stationary portion of a valve construction (not shown). Valve element 10 includes a flat surface 12 and a hole 14 defined in valve element 10 with hole 14 being open at surface 12. In the illustrated example, hole 14 is a cylindrical hole having a diameter D14. When used in a valve construction, a seal material must be installed and retained in hole 14 with the seal material terminating at surface 12. In general, the seal material is a flexible material (e.g., an elastomeric material) that will seal against another rigid element (not shown) of the valve in which valve element 10 is installed. It is to be understood that the particular configuration/size of valve element 10 to include its surface 12 and hole 14 are not limitations of the present invention.

The piece of seal material 20 is a flexible seal material that can be selected from the various materials listed above. In general, seal material 20 is in the form of a solid elongate structure. For example, if hole 14 is a cylindrical hole as shown, seal material 20 can be a solid cylinder having a diameter D20 when seal material 20 is in its free-state condition (i.e., unencumbered) in an environment whose temperature is greater than the freezing temperature of the material used for seal material 20. For example, for elastomeric seal materials, a room temperature (air)
A method of installing a valve seat, comprising the steps of:

1. A method of installing a valve seat, comprising the steps of:
   - providing a valve element having a hole defined in a surface of said valve element, said hole having a hole diameter; providing a seal material having a freezing temperature; stretching said seal material wherein a portion thereof has a reduced diameter that is less than said hole diameter; immersing said portion of said seal material in a first environment having a temperature that is less than said freezing temperature of said seal material; and cutting said material to include reduced diameter portion.

2. The method of claim 1, wherein said first environment is a cryogenic liquid environment.

3. The method of claim 1, wherein said cutting is performed using cutting tools.

4. The method of claim 1, wherein said cutting is performed using cutting tools.

5. The method of claim 1, wherein said cutting is performed using cutting tools.

6. The method of claim 1, wherein said cutting is performed using cutting tools.

7. The method of claim 1, wherein said cutting is performed using cutting tools.

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98. The method of claim 1, wherein said cutting is performed using cutting tools.

99. The method of claim 1, wherein said cutting is performed using cutting tools.

100. The method of claim 1, wherein said cutting is performed using cutting tools.
immersing includes the step of immersing said valve element in said second environment.

2. A method of installing a valve seat, comprising the steps of:
   - providing a valve element having a hole defined in a surface of said valve element, said hole having a hole diameter;
   - providing a seal material having a freezing temperature;
   - stretching said seal material wherein a portion thereof has a reduced diameter that is less than said hole diameter;
   - immersing said portion of said seal material in a first environment having a temperature that is less than said freezing temperature of said seal material wherein said reduced diameter of said portion is fixed in said first environment;
   - placing said portion in said hole of said valve element;
   - placing said valve element with said portion in said hole in a second environment having a temperature that is greater than said freezing temperature of said seal material; and
   - cutting, in said second environment, through said portion at said surface of said valve element.

3. A method according to claim 2, wherein said step of immersing includes the step of immersing said valve element in said first environment.

4. A method according to claim 3, wherein said step of placing said portion in said hole in said valve element occurs in said first environment.

5. A method according to claim 2, wherein said step of placing said portion in said hole in said valve element occurs in said second environment.

6. A method according to claim 2, wherein said hole diameter is smaller than a diameter of said seal material prior to said step of stretching.

7. A method according to claim 2, wherein said reduced diameter of said portion is smaller than said hole diameter and is in the range of approximately 35% to approximately 50% smaller than a diameter of said seal material prior to said step of stretching.

8. A method according to claim 2, wherein said hole diameter is approximately 25% smaller than a diameter of said seal material prior to said step of stretching, and wherein said reduced diameter of said portion is smaller than said hole diameter and is in the range of approximately 35% to approximately 50% smaller than said diameter of said seal material prior to said step of stretching.

9. A method according to claim 2, wherein said first environment comprises a bath of liquid nitrogen.

10. A method according to claim 2, wherein said seal material comprises an elastomeric material.

11. A method according to claim 2, wherein said step of stretching occurs in said second environment.

12. A method of installing a valve seat, comprising the steps of:
   - providing a rigid valve element having a hole defined in a surface of said rigid valve element, said hole having a hole diameter;
   - providing a cylindrical piece of elastomeric material having a freezing temperature;
   - stretching said cylindrical piece wherein a first portion of said cylindrical piece has a reduced diameter that is less than said hole diameter, and wherein a second portion of said cylindrical piece has a non-reduced diameter that is greater than said hole diameter;
   - placing said first portion in said hole of said rigid valve element;
   - placing said rigid valve element with said first portion in said hole in an environment having a temperature that is greater than said freezing temperature of said elastomeric material; and
   - cutting, in said environment having a temperature that is greater than said freezing temperature of said elastomeric material, through said first portion at said surface of said rigid valve element.

13. A method according to claim 12, wherein said step of immersing includes the step of immersing said rigid valve element in said liquid.

14. A method according to claim 13, wherein said step of placing said first portion in said hole in said rigid valve element occurs in said liquid.

15. A method according to claim 12, wherein said step of placing said first portion in said hole in said rigid valve element occurs in said environment having a temperature that is greater than said freezing temperature of said elastomeric material.

16. A method according to claim 12, wherein said hole diameter is approximately 25% smaller than said non-reduced diameter of said second portion.

17. A method according to claim 12, wherein said reduced diameter of said first portion is smaller than said hole diameter and is in the range of approximately 35% to approximately 50% smaller than said non-reduced diameter of said second portion.

18. A method according to claim 12, wherein said hole diameter is smaller than said non-reduced diameter of said second portion, and wherein said reduced diameter of said first portion is smaller than said hole diameter and is in the range of approximately 35% to approximately 50% smaller than said non-reduced diameter of said second portion.

19. A method according to claim 12, wherein said liquid comprises liquid nitrogen.

20. A method according to claim 12, wherein said step of stretching occurs in said environment having a temperature that is greater than said freezing temperature of said elastomeric material.