

# STANDARD SPECIFICATION

## INERT CERAMIC BALLS

### 1. Scope

- 1.1 This Standard Specification describes the general chemical and physical requirements for inert ceramic balls (ICB). This Standard Specification also describes the means of testing for the required properties and the acceptance criteria to be used.
- 1.2 Exceptions or variations shown in the UOP Project Specifications take precedence over the requirements shown herein.

### GENERAL REQUIREMENTS

- 2.1 Materials considered for use shall have demonstrated satisfactory performance in the same service.
- 2.2 Inert ceramic balls (ICB) are used as:
  - a. support material beneath catalyst or other granular material
  - b. hold down material on top of a bed of catalyst or other granular material
  - c. filler material where a reactive material (e.g., catalyst) is undesirable (e.g., a low flow area subject to coke formation)
  - d. material to occupy a volume while creating minimal pressure drop for flowing fluids
  - e. a means of developing a back-pressure to aid in flow distribution (especially for vapor flow).
- 2.3 The UOP Project Specifications provide the following information:
  - a. Location(s) where the ICBs are to be placed
  - b. Size(s) of ICBs to be placed at each location
  - c. The depth of each layer of ICBs or the volume to be filled by the ICBs
  - d. The Type of ICB to be placed at each location
- 2.4 ICBs shall be new. Except as noted in Paragraph 2.5, recycled, reconditioned, or reclaimed ICBs shall not be used under any circumstances.
- 2.5 Reuse of ICBs that are unloaded as the granular material in a vessel is unloaded, may be considered under the following circumstances:
  - a. The ICBs are reused in the same process and service in which they were previously used.
  - b. The ICBs are reused at the same site as they were previously used.
  - c. The ICBs do not leave the site between unloading and reuse.

- d. ICBs from different manufacturers shall not be mixed.
- e. Prior to reuse, the ICBs are separated by size and screened to remove all over or undersize (e.g., broken, fines) pieces.
- f. The ICBs are undamaged, e.g., they are not cracked, they have not absorbed any chemicals, etc.
- g. The ICBs are stored in sealed containers, in a shelter, protected from the elements and moisture (e.g., dew, humidity, spills) from the time they are unloaded until they are reused.
- h. IBC's shall not be reconditioned under any circumstances.

**2.6** The testing requirements of the following sections apply to, and shall be met by, each size of ICB. Intact ICBs shall be tested; ICBs shall not be crushed or otherwise altered. The manufacturer shall determine the frequency of each test. Tests shall be performed on each manufactured batch as necessary for quality control of the manufacturing process. Other tests shall be performed periodically to demonstrate that the type and size of ICB meets the requirements of this specification. Additional testing shall be performed as required by the purchaser.

### **3. CHEMISTRY REQUIREMENTS**

**3.1** ICBs shall be inert to the process atmosphere, i.e., neither affecting nor affected by the environment to which they are exposed.

**3.2** The chemical makeup of each ICB Type shall be as follows:

Type 1 - The combined alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ) content of the material shall be a minimum of 90 weight percent, with a maximum silica ( $\text{SiO}_2$ ) content of 80 weight percent.

Type 2 - The combined alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ) content of the material shall be a minimum of 90 weight percent, with a maximum silica ( $\text{SiO}_2$ ) content of 80 weight percent.

Type 3 – A very pure, 99+ percent alumina product, with a maximum silica ( $\text{SiO}_2$ ) content of 0.5 weight percent.

- 3.3 A sample of each size of the specified Type of ICB shall be tested for water absorption in accordance with ASTM C-830 (i.e., the sample is thoroughly oven dried, placed under a vacuum to evacuate the pores, then saturated by water under pressure to ensure completely filling the pores). The water absorbed shall not exceed the following:
- Type 1 - 3.0 weight percent
  - Type 2 - 0.9 weight percent
  - Type 3 - 3.0 weight percent
- 3.4 The leachable iron content as iron oxide ( $\text{Fe}_2\text{O}_3$ ) shall be a maximum of 0.1 weight percent. The leachable iron shall be determined by boiling 0.11 pounds (50 grams) of ICBs in a 10% hydrochloric acid solution for 64 hours.

#### 4. PHYSICAL REQUIREMENTS

- 4.1 All material shall be suitable for operating temperatures up to 1800°F (980°C).
- 4.2 **All ICBs shall be essentially spherical in shape. The ratio of the maximum diameter to minimum diameter of any ICB shall not exceed 1.20.**
- 4.3 The loose filled ICB density shall be a minimum of 85 lb/ft<sup>3</sup> (1360 kg/m<sup>3</sup>). The material (piece) density shall be at least 135 lb/ft<sup>3</sup> (2160 kg/m<sup>3</sup>).
- 4.4 The ICBs shall not "dust"; i.e., produce small fines, spall, or fracture due to abrasion between ICBs or with the container when handled or vibrated.
- 4.5 ICBs shall pass a high-pressure shock test. The test consists of heating 0.5 gallons (2 liters) of ICBs to 850°F (454°C) in an autoclave under 100 percent hydrogen pressure of 1500 psi (106 kg/cm<sup>2</sup>) for at least 1 hour. Reduce the pressure from the specified pressure to zero in less than one second. Inspect the ICBs for breakage and test for crushing strength. Compare the results with those prior to the high-pressure shock test. The compared results shall be consistent with the following:
- |                         |                        |
|-------------------------|------------------------|
| Fracturing or spalling: | 99% of the ICBs intact |
| Crushing strength:      | No loss of strength    |
- 4.6 ICBs shall pass an attrition test where 5 pounds (2.25 kg) of ICBs are placed into an 18-inch (450 mm) diameter rubber lined drum with round ribs. The drum is sealed and rotated at a rate of 60 rpm for 30 minutes. Remove the ICBs from the drum, screen on a 10-mesh screen, and weigh. The loss of weight shall be less than one weight percent.
- 4.7 A randomly selected sample of 30 ICBs shall withstand the following impact test without fracture or spalling. Testing shall be performed on the same set of ICBs used for the quench test (Paragraph 4.8), both before and after the quench test. The ICBs shall be dropped (free fall), one at a time, onto a steel plate from a height of 20 feet (6 meters).

- 4.8** ICBs shall withstand the following quench test without fracture or spalling. ICBs shall be heated to at least 925°F (500°C), held for 30 minutes at temperature, removed, and immediately dropped into 165°F (75°C) water.
- 4.9** The diameter range and minimum crushing strength for each size of ICB shall be as indicated below. The crushing strength shall be the actual gauge reading when a single ICB is pressed between two steel plates.

| <b>Size (Nominal Diameter)</b> | <b>Diameter Range (Greater Than / Less Than, Inclusive)</b> | <b>Crushing Strength (Minimum)</b> |
|--------------------------------|---|------------------------------------|
| 1/8" (3 mm)                    | 0.08" (2 mm) / 0.17" (4 mm)                                 | 50 lb (23 kg)                      |
| 1/4" (6 mm)                    | 0.20" (5 mm) / 0.30" (8 mm)                                 | 120 lb (55 kg)                     |
| 3/4" (19 mm)                   | 0.65" (17 mm) / 0.85" (21 mm)                               | 950 lb (430 kg)                    |
| 1-1/2" (38 mm)                 | 1.38" (35 mm) / 1.58" (40 mm)                               | 2000 lb (910 kg)                   |

## **SHIPPING**

- 5.1** ICBs shall be shipped and stored in sealed steel drums. The ICBs shall be enclosed in a heavy gauge polypropylene bag inside of the drum.
- 5.2** Prior to loading into the drum, each nominal size of ICB shall be screened to remove broken pieces, fines, and any material smaller or larger than the tolerance limits specified for the nominal size (see Paragraph 4.9).
- 5.3** ICBs shall not be exposed to moisture. Drums shall be stored in a sheltered location, protected from the environment. They shall be elevated above the floor and the floor shall slope away from the storage site to prevent ponding of water.
- 5.4** The drums and bags shall not be opened until the ICBs are to be loaded into the vessel. If samples are required, the bag and drum shall be resealed immediately after the samples are obtained.

## **LOADING**

- 6.1** The ratio of the nominal diameters of material in adjacent layers shall not exceed three (3).
- 6.2** If there is evidence of fines, breakage, or out of size tolerance ICBs, each nominal size of ICB shall be screened prior to loading to remove broken pieces, fines, and any material smaller or larger than the tolerance limits specified for the nominal size (see Paragraph 4.9).
- 6.3** The depth of each layer shall be uniform within ½ inch of the specified nominal depth.
- 6.4** Each layer shall contain only the specified diameter of inert ceramic balls.