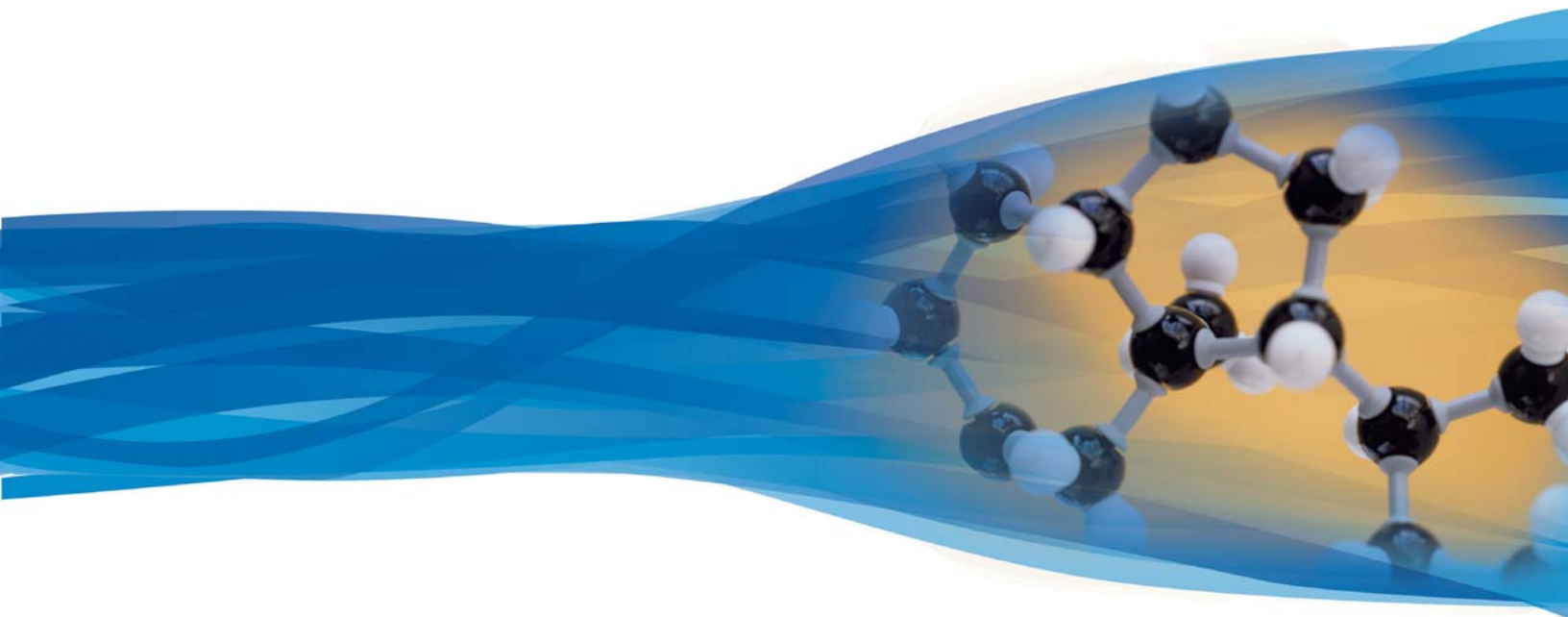


# Sponge Metal™ Catalysts

Solutions for the Synthesis of Pharmaceuticals, Bulk and Fine Chemicals



Johnson Matthey  
Catalysts

Sponge Metal™ catalysts are used for many of the same heterogeneous chemistries or processes as supported precious metal catalysts. The most common type of reaction are three phase, gas-liquid-solid reactions. Sponge Metal catalysts can be easily separated at the end of the reaction. For slurry phase Sponge Metal catalysts, settling, filtration and decantation are common ways to separate the catalyst. Other methods less commonly used in the industry are centrifugation and magnetic separation.

Sponge Metal catalysts are prepared from alloys of transition metals and aluminum. The aluminum is leached from the alloy structure, leaving behind an active metal surface covered or saturated with adsorbed hydrogen. The activated catalysts are stored under water to protect them from oxidation. Sponge Metal catalysts are in the fully active form when shipped and require no preactivation prior to use. Sponge Metal catalysts are used mainly in hydrogenation, reductive alkylation and dehydrogenation reactions.

# Sponge Metal™ Catalysts

Solutions for the Synthesis of Pharmaceuticals, Bulk and Fine Chemicals

## Safety and Handling

Activated Sponge Metal catalysts are all potentially pyrophoric. Fresh catalyst is shipped under a protective layer of water to prevent immediate oxidation by air. In the event of a splash or spill, please refer immediately to the Material Safety Data Sheet (MSDS) for detailed up-to-date information about hazards and safe handling recommendations. If any further information is required, please contact your local sales representative or any local sales office listed on the back cover of this brochure.

## Packaging and Storage

Sponge Metal catalysts are typically supplied in open-head steel drums. Please refer to the enclosed insert for further packaging options.

Catalysts should always be stored in sealed containers until required for use. Drums should be kept in a cool, dry place under reasonable conditions (not exposed to the elements of weather and extremes of temperature — ideally kept between 5 to 30°C). Drums should not be stored near oils or flammable liquids or exposed to combustible vapors due to the risk of fire. After use, empty drums can often be retained for shipment of spent catalyst for recycling purposes.

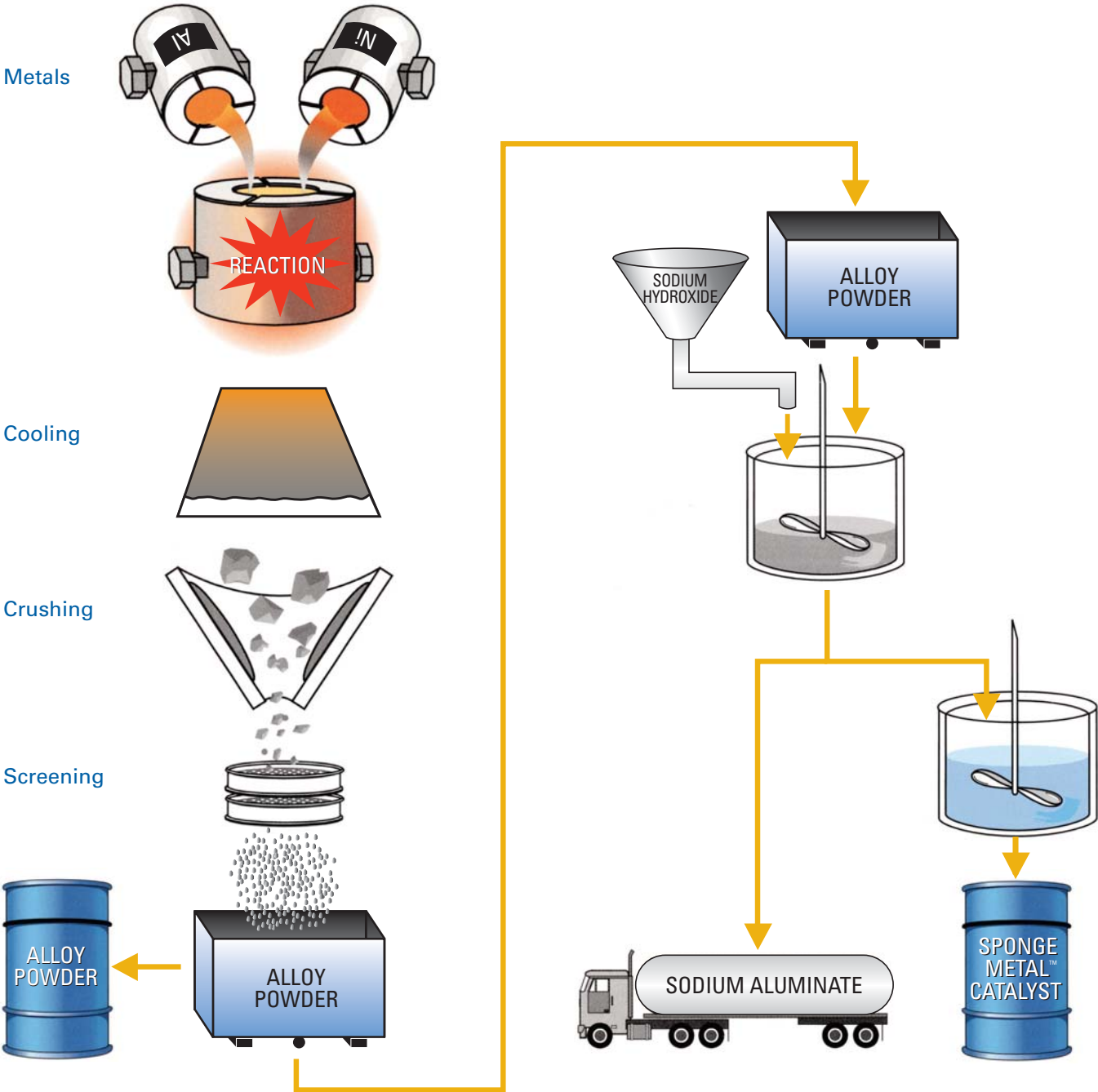
## AMCAT® Specialty Encapsulated Catalysts

Proprietary Johnson Matthey AMCAT catalysts are activated Sponge Metal encapsulated catalysts in which water has been displaced by an aliphatic amine. AMCAT catalysts are in the form of solid 1/2 inch (~13mm) cubes that are non-pyrophoric. The active catalyst powder is released after charging into the desired feedstock and/or solvent. AMCAT catalysts offer unique handling and safety properties, as well as being highly effective catalysts particularly for the hydrogenation of nitriles to amines or reductive alkylation to amines.

AMCAT catalysts offer plant operators the following benefits:

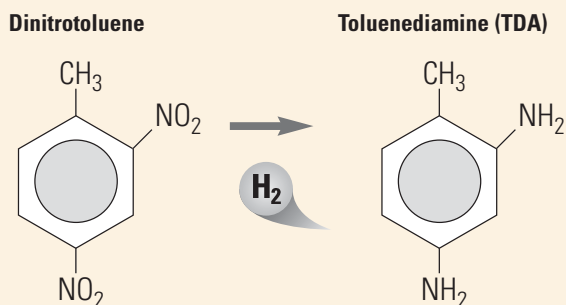
- Air stable form of Sponge Metal catalyst
- Non-pyrophoric
- Non-dusting
- Easy to weigh
- No water added to process
- Lower catalyst consumption
- Higher yields / better selectivity
- No pre-activation required
- Size of AMCAT can be adjusted
- Useful across full range of C8-C22 amines
- Various amine coatings available for direct compatibility with customer's product

In 1927, a patent<sup>1</sup> was awarded to Murray Raney of Tennessee for a new class of metal catalysts produced from the alloys of various base metals with aluminum.



<sup>1</sup> Murray Raney, US Patent 1,628,190 (1927)

## Hydrogenation of Nitro Groups to Amines



### Reaction Conditions<sup>1</sup>

**Temperature** 100-200°C  
**Pressure** 10-200 atm  
**Typical Catalyst**  
 A-5000, A-2000, A-5E09

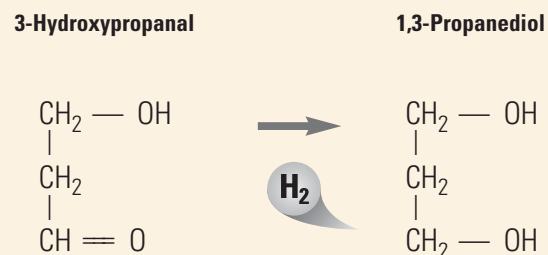
### Other Applications

2-Nitro-2-methyl-1-propanol to  
 2-Amino-2-methyl-1-propanol  
 Nitrobenzene to Aniline

### Typical Catalyst

A-5000, A-7000  
 A-5000, A-3800

## Hydrogenation of Carbonyl Groups



### Reaction Conditions<sup>2</sup>

**Temperature** 50-175°C  
**Pressure** 13-150 atm  
**Typical Catalyst** A-5000,  
 A-7000, A-7200, A-7263

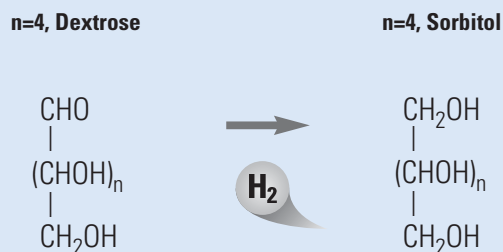
### Other Applications

Butyraldehyde to Butanol  
 Benzaldehyde to Benzyl Alcohol  
 2-Ethylhexanal to 2-Ethylhexanol

### Typical Catalyst

A-5000, A-7000  
 A-5000, A-7000  
 A-5000, A-3800

## Hydrogenation of Polyols



### Reaction Conditions

**Temperature** 100-150°C  
**Pressure** 20-200 atm  
**Typical Catalyst**  
 A-7063, A-7B63, A-7363

### Other Applications

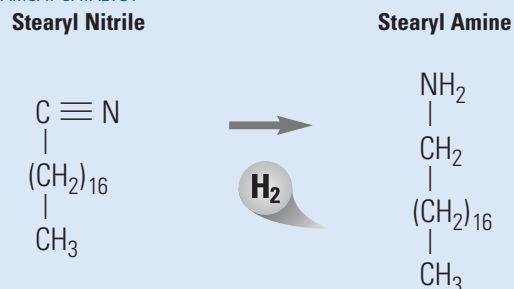
Mannitol  
 Maltitol  
 Xylitol  
 Lactitol

### Typical Catalyst

A-7063, A-7B63, A-7B73  
 A-7063, A-7B63, A-7B73  
 A-7063, A-7B63, A-7B73  
 A-7063, A-7B63, A-7B73

## Hydrogenation of Fatty Nitriles to Fatty Amines

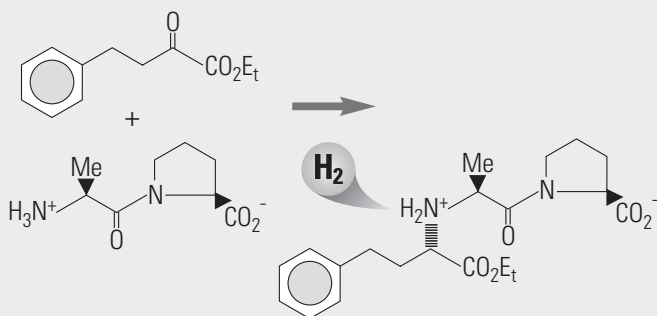
USING AMCAT CATALYST



### Reaction Conditions

**Temperature** 40-200°C  
**Pressure** 10-30 atm  
**Typical Catalyst** AMCAT-5,  
 AMCAT-7, AMCAT-2, A-8B46

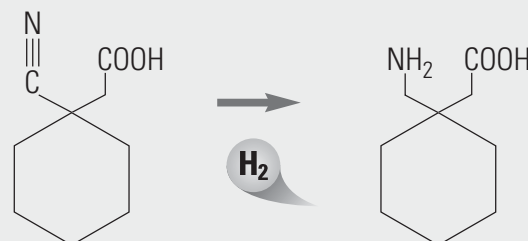
## Reductive Alkylation (Stereoselective)<sup>4</sup>



### Reaction Conditions

**Temperature** RT  
**Pressure** 3 atm  
**Typical Catalyst** A-5000

## Hydrogenation of Nitriles to Amines<sup>5</sup>



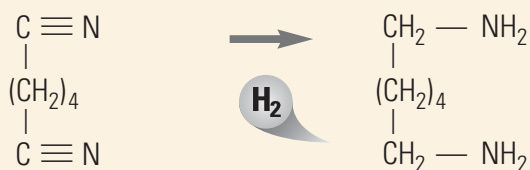
### Reaction Conditions

**Temperature** RT  
**Pressure** 12 atm  
**Typical Catalyst**  
 A-7000, A-5000, A-7063

## Hydrogenation of Nitriles to Amines

**Adiponitrile**

**Hexamethylenediamine (HMDA)**



### Reaction Conditions

**Temperature** 60-100°C

**Pressure** 20-50 atm

**Typical Catalyst** A-4000

### Other Applications

Diaminobutane

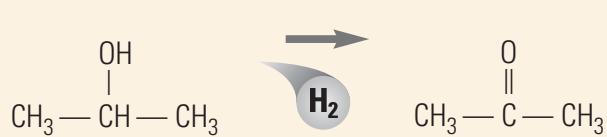
### Typical Catalyst

A-4000

## Dehydrogenation of Alcohols

**Isopropyl Alcohol**

**Acetone**



### Reaction Conditions<sup>3</sup>

**Temperature** 170-230°C

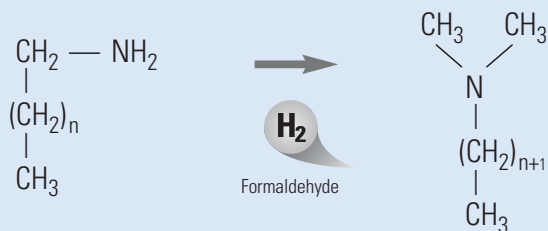
**Typical Catalyst**

A-4000, A-7000

## Reductive Alkylation

**Aliphatic Primary Amine**

**Tertiary Dimethyl Aliphatic Amine**



### Reaction Conditions

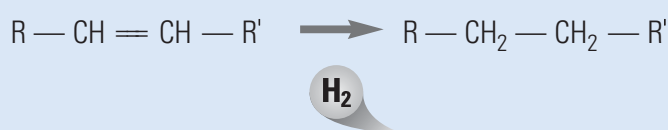
**Temperature** 150-180°C

**Pressure** 1-3 atm

**Typical Catalyst** AMCAT-5,

AMCAT-7, AMCAT-5343

## Hydrogenation of Olefins to Alkanes



### Reaction Conditions

**Temperature** 25-200°C

**Pressure** 1-200 atm

**Typical Catalyst** A-5000

### Other Applications

Crotonaldehyde to Butyraldehyde

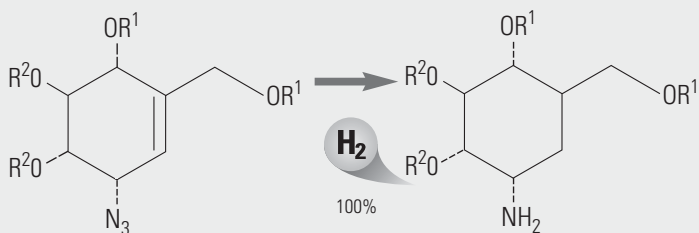
Sulfolene to Sulfolane

### Typical Catalyst

A-5000

A-5000

## Hydrogenation of Azide and Olefin<sup>6</sup>



### Reaction Conditions

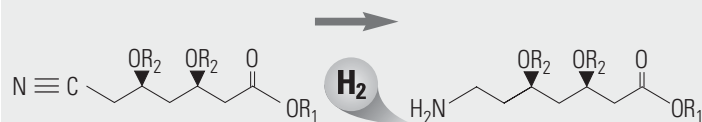
**Temperature** RT

**Pressure** 3 atm

**Typical Catalyst**

A-5000, A-5E09

## Hydrogenation of Nitriles to Amines<sup>7</sup>



### Reaction Conditions

**Temperature** RT

**Pressure** 3 atm

**Typical Catalyst**

A-7000, A-5000

# Sponge Metal Catalyst Product Listing

| Sponge Family          | Catalyst                 | Primary Active Component | Nominal Composition, % |               | Typical Median Particle Size, microns | Comments |
|------------------------|--------------------------|--------------------------|------------------------|---------------|---------------------------------------|----------|
|                        |                          |                          | Promoters              | Aluminum      |                                       |          |
| <b>Nickel</b>          | A-2000                   | Nickel                   | 13 Fe                  | 6.3           | 29                                    |          |
|                        | A-5000                   | Nickel                   | –                      | 6.8           | 33                                    |          |
|                        | A-5001                   | Nickel                   | –                      | 6.6           | 33                                    | Low pH   |
|                        | A-5009                   | Nickel                   | –                      | 5.0           | 33                                    |          |
|                        | A-5E09                   | Nickel                   | –                      | 6.8           | 20                                    |          |
|                        | A-5B00                   | Nickel                   | –                      | 6.0           | 50                                    |          |
|                        | A-5200                   | Nickel                   | –                      | 6.6           | 166                                   |          |
|                        | A-5300                   | Nickel                   | –                      | 7.0           | 118                                   |          |
|                        | <b>Nickel/Molybdenum</b> | A-7000                   | Nickel                 | 2.1 Mo        | 8.2                                   | 35       |
| A-7004                 |                          | Nickel                   | 2.1 Mo                 | 8.1           | 35                                    | Low pH   |
| A-7063                 |                          | Nickel                   | 1.1 Mo                 | 6.7           | 34                                    |          |
| A-7B63                 |                          | Nickel                   | 1.1 Mo                 | 6.5           | 52                                    |          |
| A-7B73                 |                          | Nickel                   | 1.1 Mo                 | 6.5           | 51                                    |          |
| A-7200                 |                          | Nickel                   | 2.4 Mo                 | 8.8           | 160                                   |          |
| A-7263                 |                          | Nickel                   | 1.3 Mo                 | 7.3           | 166                                   |          |
| A-7363                 |                          | Nickel                   | 1.3 Mo                 | 7.3           | 123                                   |          |
| <b>Nickel/Chromium</b> |                          | A-4000                   | Nickel                 | 2.2 Fe 2.5 Cr | 10.3                                  | 33       |
| <b>Copper</b>          | A-3B00                   | Copper                   | –                      | 1.2           | 60                                    |          |
| <b>Cobalt</b>          | A-8B46                   | Cobalt                   | 2.9 Ni 1.8 Cr          | 4.0           | 66                                    |          |

|              |            |        |      |     |    |                       |
|--------------|------------|--------|------|-----|----|-----------------------|
| <b>AMCAT</b> | AMCAT-2    | Nickel | 7 Fe | 3.0 | 29 | Primary amine coated  |
|              | AMCAT-5    | Nickel | –    | 3.6 | 33 | Primary amine coated  |
|              | AMCAT-5343 | Nickel | –    | 3.2 | 33 | Tertiary amine coated |
|              | AMCAT-7    | Nickel | Mo   | 4.1 | 35 | Primary amine coated  |
|              | A-5000 WO  | Nickel | –    | 6.8 | 33 | Covered in white oil  |
|              | A-7000 WO  | Nickel | Mo   | 8.2 | 35 | Covered in white oil  |

## ALLOY POWDERS

All precursor catalyst alloy powders along with custom alloy powders are available upon request.

## Quality Travels with Sponge Metal™ and AMCAT® Products

Packaging is a product and can be customized. Packaging options provide many benefits to production plant operators, warehouse personnel, health and safety professionals, and supply chain managers.

- English or Metric weights and measures
- International labeling to conform with all current legislation
- Client product code information
- Matching drum weight with process batch size to prevent errors associated with weighing or scooping
- Color coding of drum for inventory control and batch size procedures
- Optional drum liners can help with drum emptying in certain types of equipment
- Steel drums may be reused for shipping spent catalyst to the metal reclaimer (if permitted by local regulations)

### Sponge Metal Catalyst Standard Packaging

Catalysts are shipped as water-based slurries, with a visible excess of liquid.

|  |   |               |              |              |             |
|--|---|---------------|--------------|--------------|-------------|
| <b>Net Solids Weight, pounds (kg)</b>      | 350<br>(158.8)  | 200<br>(90.7) | 110<br>(50)  | 35<br>(15.8) | 12<br>(5)   |
| <b>Gross Volume, gallons (US) (liters)</b> | 55<br>(210.8)   | 30<br>(114)   | 16<br>(60.5) | 5<br>(18.9)  | 3<br>(11.5) |
| <b>Material</b>                            | All drums are steel, equipped with automatic pressure relief valves |               |              |              |             |
| <b>Shipping Classification</b>             | UN1378, Metal Catalyst, Wetted                                      |               |              |              |             |

### AMCAT Catalyst Standard Packaging

|  |                                  |              |
|--|----------------------------------|--------------|
| <b>Net Solids Weight, pounds (kg)</b>      | 350<br>(158.8)                   | 35<br>(15.8) |
| <b>Gross Volume, gallons (US) (liters)</b> | 55<br>(210.8)                    | 5<br>(18.9)  |
| <b>Material</b>                            | Steel                            | Plastic      |
| <b>Shipping Classification</b>             | UN1759, Corrosive Solids, n.o.s. |              |



## Sponge Metal Catalyst Recovery

When the catalyst has come to the end of its active life, Johnson Matthey offers services for reclamation of metal value. After use, the filtered catalyst should be washed with a suitable solvent, followed by water to reduce organics content to a minimum. Spent catalysts should be sealed and stored away from any combustible vapors. Many supported catalysts are more pyrophoric after use in a hydrogenation reaction due to hydrogen absorption. Catalyst filtration should be done under an inert atmosphere and the filter cake should not be allowed to 'dry out.' The filter cake should be washed thoroughly with water.

Spent catalyst residues classed as materials for recycling and the transport of these residues are subject to current regulations. Johnson Matthey can offer advice about the regulations that apply

## Approved Weighing Method

An accurate means for weighing Sponge Metal catalysts is by use of a Guy-Lussac specific gravity bottle. A 10 ml volume is sufficient for weighing catalyst amounts up to a gram. The Guy-Lussac bottle, the rinse water bottle, and the catalyst should all be equilibrated to the same temperature prior to the measurement. The weighing procedure is as follows:

1. Rinse the specific gravity bottle with deionized water and fill over-full with deionized water. Plunge the stopper into the bottle with a smooth, swift motion to seat it properly. Wipe the outside of the bottle dry with tissue.
2. Weigh the bottle to as many significant places as possible. Record the mass as "Mass A."
3. Remove the stopper and pour out about half the water.
4. Mix the sample of catalyst vigorously before transferring to the specific gravity bottle, to ensure as uniform a sample as possible. Particle size segregation is common when powdered

to different materials. However, the final classification of any spent material is the responsibility of the shipper and should be based on the composition and characteristics of that material.

In addition to the regulations governing waste shipments, all movements of catalyst residues must be classified and labeled according to current international transport regulations. Material originating within the European Union must also be classified and labeled for supply in accordance with Directive 1999/45/EC.

To ensure safe treatment of the residues and to meet European Health and Safety legislation, Johnson Matthey requires a Material Safety Data Sheet for each residue returned. Other material contaminated with base metals, such as wipes, filter cloths, distillation residues, etc., should be returned in a separate marked drum for metal reclamation.

catalyst settles. Particle size has a major influence on catalyst activity with slurry reactions. Sampling a coarser or finer fraction of the catalyst may give misleading experimental results.

5. Transfer the catalyst to the specific gravity bottle. Catalyst may be removed with a pipette or large-bore syringe, preferably while the catalyst is stirred.
6. Fill the bottle over-full with deionized water. Plunge the stopper into the bottle with a smooth, swift motion to seat it properly. Wipe the outside of the bottle dry with tissue.
7. Weigh the bottle to as many significant places as possible. Record the mass as "Mass B."
8. Calculate the actual solid Sponge Metal catalyst weight as follows:  $\text{Catalyst Mass} = 1.167 \times (\text{Mass B} - \text{Mass A})$ .
9. The weighed catalyst may now be transferred to another container. The catalyst surface should be covered with water or suitable solvent. Decant excess liquid if necessary.



# Johnson Matthey Catalysts

For further information about our products or to talk to us about your individual requirements,  
please contact your local sales office or contact us at the addresses below.

1246 Airport Road  
Ray L. Reagan Industrial Park  
Sevierville, TN 37862  
USA  
Tel +1 (865) 453 7177  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

2001 Nolte Drive  
West Deptford, NJ 08066  
USA  
Tel +1 (856) 384 7151  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

Wardstrasse 17  
D-46446 Emmerich am Rhein  
Germany  
Tel +49 (0) 2822 91410  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

Orchard Road  
Royston, Hertfordshire  
SG8 5HE  
United Kingdom  
Tel +44 (0) 1763 253000  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

88 Dong Xin Road  
Song Jiang Industrial Zone  
Shanghai 201613  
China  
Tel +86 21 5771 1234  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

Plot No. 6  
MIDC Industrial Estate  
Taloja  
District Raigad  
Maharashtra 410208  
India  
Tel +91 22 27 401427  
Fax +1 (865) 428 3446  
Email [spongecatalysts@jmusa.com](mailto:spongecatalysts@jmusa.com)

[www.jmcatalysts.com/pct](http://www.jmcatalysts.com/pct)