# HiFUEL® Base Metal Water Gas Shift Catalysts

Johnson Matthey is a world leading developer of catalysts and processes for hydrogen generation from a range of feedstocks. The HiFUEL® catalyst range is designed specifically for distributed hydrogen generation systems and includes both base metal and precious metal formulations.

This data sheet provides some guidance on typical operating conditions for the HiFUEL™ base metal range of water gas shift (WGS) catalysts.

Fuel cells are being developed for a range of stationary, mobile and portable power generation applications. Fuel processors generate a hydrogen rich reformate feed for the fuel cell from readily available hydrocarbons such as natural gas, LPG, methanol and gasoline.

The reformate gas contains carbon monoxide (CO) which can act as a fuel cell poison. The level to which CO must be removed depends on the type of fuel cell.

CO levels can be reduced efficiently using the WGS reaction. This converts carbon monoxide (CO) and water in the reformate stream into carbon dioxide ($CO_2$) and hydrogen ($H_2$). The water-gas shift reaction is exothermic, and high conversion is favoured at lower temperatures and higher steam-to-dry gas ratios. WGS beds are commonly designed with high and low temperature stages to minimise the reactor volume while maximising CO conversion.

HiFUEL® base metal Water Gas Shift (WGS) catalysts are available for low, medium and high temperature applications.

All three WGS catalysts:
- Allow for flexible operations at a variety of steam-to-dry gas ratios
- Are presented in mini-pellet design
- Offer excellent strength and packing characteristics

HiFUEL® W210 is not readily susceptible to poisons and the manufacturing process ensures that it is environmentally safe with a low concentration of water-soluble chrome, and has a negligible sulfur content so as not to poison downstream catalysts. HiFUEL® W220/230 require pre-reduction prior to use.

| Item | Description | CO reduction in vapour streams | |
|---|---|---|---|
| | | Inlet | Outlet |
| 45467 | Iron-chrome based high temperature gas shift catalyst, HiFUEL® W210 | 8-15 mol% dry | 1-4 mol% dry |
| 45466 | Copper based low temperature water gas shift catalyst, HiFUEL® W220 | 1-4 mol% dry | 0.1-0.3 mol% dry |
| 45470 | Copper based medium temperature water gas shift catalyst, HiFUEL® W230 | 6-10 mol% dry | 1-4 mol% dry |

Available in 500g, 1kg, 2.5kg sizes. Bulk quantities also available on request.

# HiFUEL® Base Metal Water Gas Shift Catalysts

| Catalyst | Physical Properties | Temperature | Pressure | Steam ratio | Catalyst Loading |
|---|---|---|---|---|---|
| **45467 (HiFUEL® W210)** | Shape: Cylindrical pellet Size: 5.4mm x 3.6mm Loaded density: 1260kg/m³ | Recommended: 320-500°C (Max:540°C) Minimum feed gas temperature: 20°C above dew point | Minimal Impact | The reduction coefficient, R defines the minimum steam ratio. It should be maintained less than 1.9 to avoid hydrocarbon formation by Fischer-Tropsch reaction. $R = \left[\frac{CO + H2}{CO + H2O}\right] \times \left[\frac{P}{26}\right]$ The gas analysis is in vol% and P is pressure (bar) | GHSV < 7500 hr-1. |
| **45466 (HiFUEL® W220)** | Shape: Cylindrical pellet Size: 3.1mm x 3.1mm Loaded density: 1360kg/m³ | Recommended: 185-250°C (Min: 185°C, Max:270°C) Minimum feed gas temperature: 20°C above dew point | | Feed gas >25% steam. | |
| **45470 (HiFUEL® W230)** | Shape: Cylindrical pellet Size: 5.5mm x 3.6.5mm Bulk density: 1400kg/m³ | Recommended: 200-350°C (Min: 200°C, Max:350°C) Minimum feed gas temperature:20°C above dew point | | Feed gas should contain some moisture (recommended >25% steam). | |

| Catalyst | Feed Quality | Activation | Handling | Disposal |
|---|---|---|---|---|
| **45467 (HiFUEL® W210)** | Sulfur, chloride and silica will reduce activity. Sulfur should be less than 100 ppm. | Supplied in non-reduced form. An activation step is not required, as the catalyst will be reduced to the active state upon start up. Wet gas should not be introduced to the catalyst until temperatures are at least 20°C above the dew point. Do not expose the catalyst to hot nitrogen for a prolonged period. This will lead to excessive drying of the catalyst, and a rehydration exotherm will result. | Avoid contact with skin and clothes. Avoid breathing dust. Do not take internally. Consult the relevant material safety data sheet for further information. | Dispose according to local guidelines; refer to SDS. |
| **45466 (HiFUEL® W220)** | Susceptible to sulfur, chloride and silica poisoning, and should be protected from these components by upstream purification. | Supplied in non-reduced form. A controlled activation is required under reducing conditions, and above the dewpoint. The reducing agent concentration should be less than 2%mol dry, and the temperature should be maintained at <230°C. | Once reduced, the catalyst is pyrophoric. Prior to discharge, the catalyst should be exposed to steam and oxidised. Avoid contact with skin and clothes. Avoid breathing dust. Do not take internally. Consult the relevant safety data sheet for further information. | Oxidation is required prior to disposal. Dispose according to local guidelines; refer to SDS. |
| **45470 (HiFUEL® W230)** | | | | |

**Johnson Matthey offers a complimentary range of precious metal fuel processing catalysts that have been developed specifically for fuel cell applications. For more information contact HiFUEL.coatedcatalysts@matthey.com.**