

# Density Grading

## An Efficient Solution to Catalyst Separation

### Description

The recovery of reusable catalyst is of key economic importance to refiners and Oleflex™ petrochemical plants.

Density Grading, a service provided by Evonik since 1993, is used to separate similar-sized catalyst particles based on their density difference. Effective separations have been accomplished on catalysts containing particles with a density difference as small as 10%.

Evonik’s proprietary Density Grading technology will maximize the yield of reusable catalyst, resulting in substantial cost savings to the refiner or to the Oleflex™ petrochemical plant.

### Examples of Density Grading applications include:

- Separation of mixtures of different catalysts, for example, the separation of hydrotreating catalyst and hydrocracking catalyst from a mild hydrocracker.
- The removal of heavy-metal contaminated catalyst from uncontaminated catalyst
- The separation of high carbon heel catalyst from reusable CCR reforming catalyst
- The separation of high carbon heel catalyst from reusable C<sub>3</sub> or C<sub>4</sub> Oleflex™ Pt-based catalysts

### Advantages

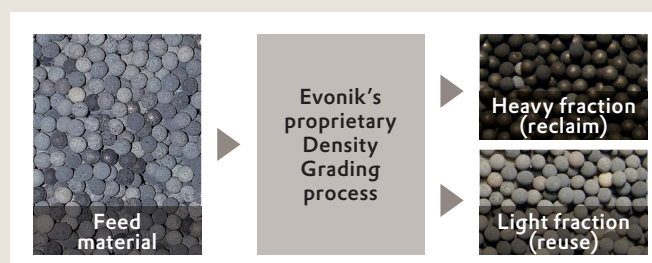
Technology to maximize the yield of reusable catalyst.



Result: Substantial cost savings to the refiner.

### Examples – Density Grading of Heel-contaminated CCR reforming and C<sub>3</sub> Oleflex™ Pt-based catalysts.

The quantity of heel-contaminated catalyst depends on unit size, unit design and unloading techniques. Typically, about 10% of the catalyst unloaded is contaminated with heel catalyst. When heel-contaminated catalyst is density graded, three fractions are produced: light, medium and heavy. The light fraction, having the lowest carbon levels, is fully reusable and is returned to the refiner. The heavy fraction contains the highest carbon levels, is not reusable and is sent for metals reclaim. The medium fraction is density graded again to maximize the recovery of reusable catalyst.



### Case study 1 - Separation Results: CCR Reforming catalyst

|  | Feed               | Lights             | Heavies           |
|--|--------------------|--------------------|-------------------|
| <b>Yields, lbs (kg)</b>  | 94,576<br>(42 900) | 83,480<br>(37 865) | 11,096<br>(5 033) |
| <b>wt%</b>   | -                  | 88.3               | 11.7              |
| <b>Average carbon, wt%</b>                                     | 5.0                | 3.8                | 14.3              |
| <b>Peak carbon, wt%</b>  | 31.4               | 6.1                | 32.3              |
| <b>Compacted Density, lb/ft<sup>3</sup> (kg/m<sup>3</sup>)</b> | -                  | 34.8<br>(557)      | 41.6<br>(667)     |

### Case study 2 - Separation Results: C<sub>3</sub> Oleflex™ Pt-based catalyst

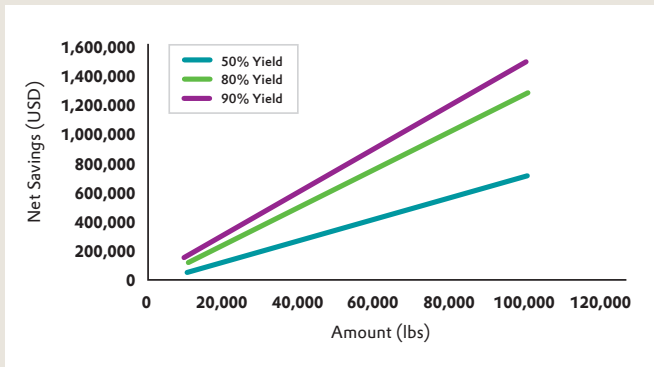
|  | Feed              | Lights            | Heavies        |
|--|-------------------|-------------------|----------------|
| <b>Yields, lbs (kg)</b>  | 17,682<br>(8 020) | 16,000<br>(7 257) | 1,682<br>(763) |
| <b>wt%</b>   | -                 | 90.5              | 9.5            |
| <b>Average carbon, wt%</b>                                     | <0.1              | <0.1              | 0.3            |
| <b>Peak carbon, wt%</b>  | 50.8              | None              | 49.3           |
| <b>Compacted Density, lb/ft<sup>3</sup> (kg/m<sup>3</sup>)</b> | -                 | 34.3<br>(550)     | 40.6<br>(651)  |

## Significant cost savings for the refiner or the Oleflex petrochemical plant

Cost savings from density grading depends on:

- The amount of catalyst to be graded
- The yield of reusable catalyst
- The catalyst replacement cost
- The metals recovery cost

### Net savings as function of catalyst size and reuse percentage



A strong economic incentive exists to use density grading to recover the low-carbon catalyst from the contaminated fraction. Particles with density differences as low as 10% can be efficiently separated while achieving a high level of selectivity during the density grading process.

All Evonik plants across the globe can provide this ex-situ service on a turnaround basis to allow the refiner or the C<sub>3</sub> / C<sub>4</sub> Oleflex™ plants reloading the low-carbon catalyst as promptly as possible.

Evonik can calculate a cost savings scenario for your specific application.

#### Disclaimer

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