



# Mixer Design Considerations Features and Criteria for Evaluating ROI

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## The Role of Mixing Agitators

Most pumps are designed to move material from point A to point B – but mixers and agitators are designed to continuously blend within a confined space, to prepare material for the next step in a defined process.

In petroleum markets, mixers blend different grades of crude oil together to create a product that meets the specifications required by refineries. Mixers also play a key role when it comes to oil storage. Crude stored in large tanks must be continuously mixed to prevent impurities from settling at the bottom of the tank, which wastes valuable storage space and could cause corrosion damage to the bottom of a tank, which would generate extremely high cleaning costs.

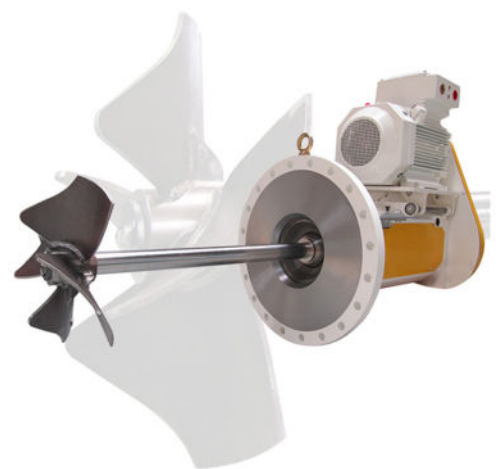
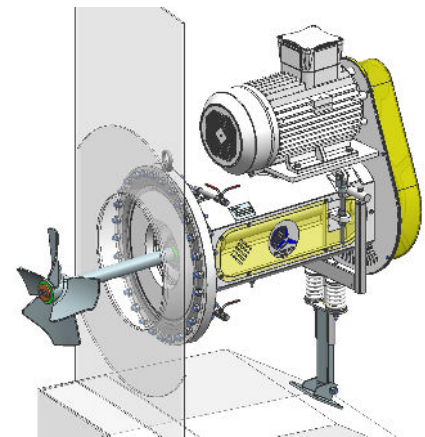
In water treatment, mixers are needed for coagulation & flocculation applications – which filter out impurities and prepare water for the next step in the treatment process. They're also used for denitrification, aeration and dewatering/sludge removal (where they have been proven to reduce sludge by more than 20-percent).

In many industries - Mixers make the world go around – but not all Mixers are created equally.



### This Mixing White Paper:

- Discusses design considerations;
- Identifies features that enhance performance;
- Evaluates maintenance requirements;
- And presents an overall value proposition that end users and OEMs should consider for selecting, operating and maintaining mixers & agitators.



The processing of crude oil features many steps, including extraction, separation, transportation, storage, blending and refining. As oil moves through each step, a variety of global factors influence supply, demand and price.



### Mixers for Crude Oil:

Storage facilities provide a buffer to balance fluctuations between supply & demand. But oil cannot sit idly in storage tanks. When crude comes out of the ground, it's accompanied by impurities that are removed prior to refining. These impurities, known as Bottom Sediment & Water (BS&W) pose an expensive risk to tank operators. When enough BS&W settles in a tank, a process called "Sanding-In" takes place, which can reduce a tank's storage volume by up to 30-percent. This diminishes a tank's capacity to generate revenue and it also creates an environmental risk by degrading the tank's integrity.

**SEDIMENT**

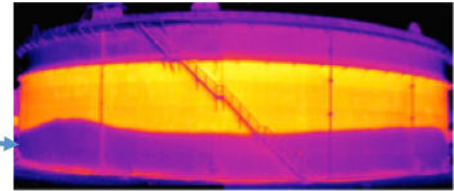
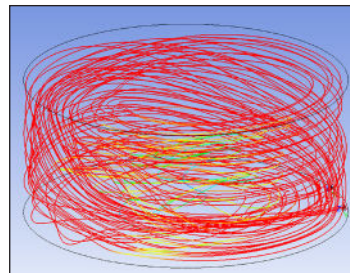


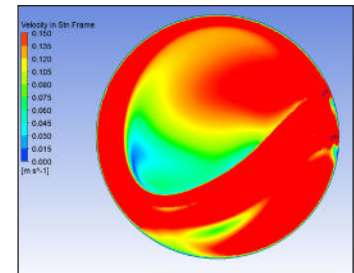
Image A

The API-653 standard addresses maintenance for storage tanks and provides guidance for inspection and cleaning schedules. The purple color at the bottom of Image A represents BS&W that has settled in. A tank with this much accumulation needs to be drained immediately for remediation. Clean-ups require specialized crews & equipment, and can cost up to a hundred-thousand dollars. They're also time-consuming, which prevents a tank from generating revenue during restoration.

The way to manage BS&W is to keep it in suspension until the crude is pumped off to a refinery. This is accomplished by attaching side entry mixers to storage tanks, which keep the crude moving in the tank and prevent BS&W from settling at the bottom.



Flow Pathways



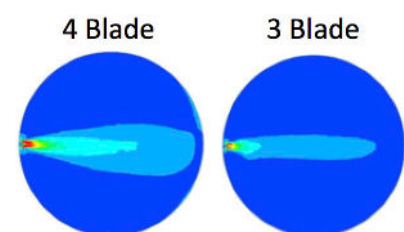
Velocity Distribution

### Blending is required for Refining:

Another critical application for mixers is the blending of heterogeneous volumes of crude stored in a tank. Shale fracking produces crude with different viscosities and impurities than oil that comes from the Middle East. Extra light crude from the US, or extra heavy crude from Canada requires mixing and blending with crude from the Middle East to create the right feedstocks required by US refineries (which were built decades ago). This blending is accomplished by mixers/agitators in storage tanks.

Blending performance makes a difference. The quicker a tank load can be blended and prepared for refining, the quicker it can be sent out, enabling the tank to accept new oil, and the revenue that comes with it. The horsepower and performance of mixers directly impacts the bottom line for tank farm operators.

Computational Fluid Dynamics (CFD) tests analyze the volume stored in a tank as well as its gravity and viscosity. This data determines the proper configurations for mixers. Numerous tests indicate how legacy, marine-style three-blade mixers require twice as much horsepower and take several hours longer to match the intensity and fluid velocity of **Milton Roy's 4-blade SABRE® impellers**.



### 25% Energy Savings:

Milton Roy mixers are designed for tanks up to 200,000 m<sup>3</sup> (1.3 MM barrels). Keeping oil moving in tanks of this size requires enormous energy – and energy costs are one of the largest expenses for operators. Milton Roy mixers minimize energy costs in two ways:

- The 4-bladed SABRE impeller provides a 25% energy savings over 3 bladed impellers with the same flow.
- The increased blending power means the equipment does not need to operate as long to complete the blend, which further reduces energy consumption.

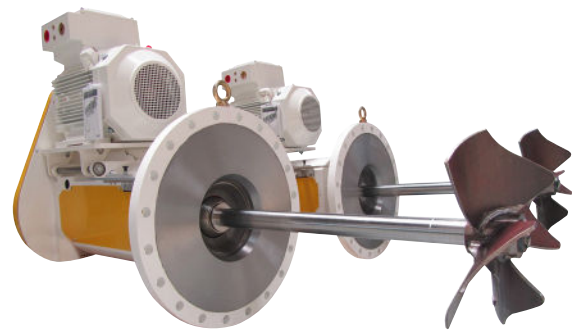
### Streamlined Maintenance:

Milton Roy mixers are designed to minimize vibration. Inboard spherical roller bearings withstand greater radial loads and they don't wear out as quickly as conical roller bearings or deep groove ball bearings. Vibration is further reduced through articulated motor support - which enables a fast belt and motor de-assembly, which does not require a senior skilled technician to maintain.

The SABRE® impeller's diameter is smaller than the flange's inside diameter – which simplifies maintenance by making the mixers easy to install or remove. The mixer's mechanical seal can be replaced quickly - even if the tank is full.

### Design Features:

- Carbon steel construction
- Belt or Gear Driven
- Variable or Fixed Angle
- HTP or reduced noise synchronous high quality belts
- Operating temperatures from 0° to 250° C (40° to 482° F)
- Operating capacity: from 100 m<sup>3</sup> to 200,000 m<sup>3</sup> (1.3 MM barrels)
- Rated power: from 7.5 to 55 kW (10 to 75 HP)
- Rotation speed: from 200 to 1,500 rpm
- IEC or Standard NEMA Motors
- 50/60 Hz
- TEFC, Ex-Proof, IEEE-841 available
- Single or Dual Mechanical Seals for Leak Prevention and Emission Control
- Simple Tank shut off device



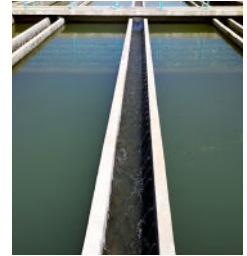
### Safety and Peace-of-Mind:

Milton Roy mixers minimize the risk of the impeller hitting the tank's inside wall, getting loose and falling to the bottom, which would require draining the tank for repairs, or it could require a person to enter the hazardous environment. Fast and efficient shutoff actuation capabilities help to ensure limited environmental impact, by lessening the potential for oil spills or leaks.

Whatever criteria operators evaluate – be it enhanced blending performance; greater energy efficiency; simplified maintenance; better reliability/safety; or a more effective means of keeping BS&W suspended in the tank – the benefits of replacing older, inefficient mixers with newer Milton Roy side entry mixers is easy to qualify.

## Mixers for Water Treatment

In both municipal treatment for drinking water and industrial treatment for wastewater, a series of steps (including disinfection, odor control, flocculation and pH control) are conducted in sequence. Top entry mixers – or agitators – play a critical role in coagulation/flocculation – which is one of the lengthiest and most important steps in the process.



The quality and turbidity of water entering a municipal potable water treatment plant (from a lake or river) varies significantly, due to storms or seasonal changes. Many of the natural impurities that accompany incoming water are miniscule particles (finer than 1 micrometer) that are too small to be filtered. These particles remain in motion due to negative electrostatic charges which cause them to repel one another. These impurities are removed from drinking water via coagulation/flocculation applications – which require top entry mixers.

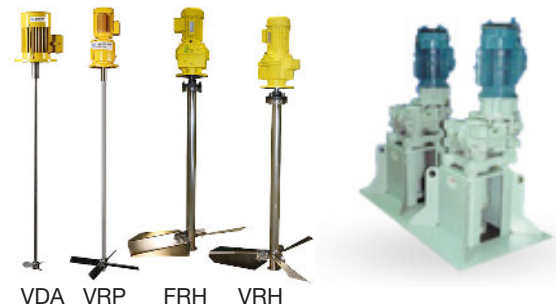
Coagulant polymers (chemicals like alum, ferric chloride, ferric sulfate, or poly-aluminum chloride) are dosed into clarifiers, to collide with millions (or billions) of negatively-charged particles. These polymers or flocculants react in a manner that causes particles to floc together, to form larger & heavier aggregates that no longer repel each other - but instead sink to the bottom of the tank where they can be filtered & removed.



Mixers/agitators continuously swirl the water in the tank to ensure that the polymers find their targets. Sensors like Milton Roy's Streaming Current Detectors constantly analyze the surface charge (on a slip stream of treated water) to track the progress. Additional rounds of polymers are dosed, and the mixers continue to swirl water in the clarifier until an acceptable level of filtration has occurred. From this stage, water moves on to the next round which includes disinfection, pH control and other treatments.

## One-Size Does Not Fit All:

Municipal water treatment plants range from small systems in rural towns, to large city plants that treat millions of gallons per day. Milton Roy supports them all. The HELISEM® Series of mixers offers 4 distinct models – VDA, VRP, VRH, and FRH – each with a specific impeller designed to support open tank applications from 10 to 100,000 gallons (50 L to 400 m<sup>3</sup>) and viscosities up to 1,000 mPas (cP), and the Robin and HM Series offer additional variants.



Milton Roy's family of efficient and high-powered mixers are ideal for open tank applications, providing greater flow and better velocity distribution for any sized tank. Milton Roy takes a holistic approach to water treatment applications. By designing and manufacturing mixers, sensors and metering pumps - Milton Roy sees the big picture when it comes to applications like coagulation & flocculation, pH balance, disinfection and others.

Mixer	Capacity	Impeller diameter	Rated power	Rotation speed
VDA	10-500 gal	80 to 160 mm 3.1 to 6.3 inches	0.25 to 1.5 kW 1/3 to 2 HP	900, 1,800 rpm
VRP	25-1,300 gal	200 to 500 mm 7.9 to 19.7 inches	0.18 to 0.37 kW 1/4 to 1/2 HP	100 to 280 rpm
VRH	500-25,000 gal	600 to 2,350 mm 23.6 to 92.5 inches	0,18 to 3 kW 1/4 to 5 HP	16 to 76 rpm
FRH	250-100,000 gal	400 to 3,600 mm 15.7 to 142 inches	0.12 to 1.1 kW 1/4 to 1 1/2 HP	7.5 to 68 rpm
Robin	0.001 to 100,000 m <sup>3</sup>	0.20 to 6 m	0.55 to 500 kW	10 to 500 rpm
HM	1 to 1,500 m <sup>3</sup>	from 200 mm to 4,200	0.37 to 37 kW	5 to 300 rpm

## Top-10 Criteria for Evaluating Mixers

When it comes to Mixers for water treatment, Milton Roy stands behind the following differentiators:

1. **Optimal Designs** – Milton Roy has more than 100 years of experience with Mixing applications
2. **Energy efficiency:** lightweight, compact and up to 70% more energy efficient than legacy mixers
3. **Patented HXP hydrofoil impeller:** outperforms PBT impellers by more than 40% from a hydraulic efficiency standpoint
4. **Flexibility:** several motor options (single phase, tri-phase, variable speed, air motor, electric)
5. **Reliability:** fewer parts and a robust shaft design features 50% fewer welds
6. **Immediate Availability:** most mixers are in-stock, and customized mixers are available through quick shipment programs
7. **Easy Installation:** via an adapter plate and standard ANSI mounting flanges
8. **Streamlined Maintenance:** no maintenance required during the first 2-3 years under normal conditions.

## 9 - Extensive Customer Support Anywhere Around the Globe

Milton Roy has manufacturing, service and support operations to reach customers quickly wherever they are located. Beyond product training & support, Milton Roy's global field organization also brings application expertise and consulting for simulations and Computational Fluid Dynamics (CFD) to help customers improve their mixing applications, and their bottom lines.

## 10 – A Track Record Second to None for Customers Large and Small

With more than 100 years of mixing expertise, the world's largest municipal water treatment plants, industrial wastewater treatment plants, and the EPCs and OEMs that service these plants all rely on Milton Roy.

One example comes from Paris, where one of the world's largest OEMs installed Milton Roy mixers for flocculation applications in 20 settling tanks at the largest wastewater treatment plant in Europe. Originally built in 1940, this plant treats almost 70% of the Parisian agglomeration's wastewater, or approximately 1.5 million cubic meters per day. It is currently undergoing a major renovation to expand capacity for water treatment and sludge recovery, while also enhancing environmental protection. Plants of this size run operations 24x7, so reliability and unwavering uptime for equipment is paramount. The OEM/EPC has a proven track record working with Milton Roy to support customers, and Milton Roy's local footprint in this area played an important role in this project.

Not all examples are large scale. Places like Southern California feature hundreds of small municipalities that draw water from local wells. In these environments, no two customers are the same, because each water source is different, and each plant requires different mixing solutions. Often times, the buyer for smaller water systems is not an experienced "pump guy" - but rather a city manager wearing many hats and facing budget constraints. When it comes to servicing such customers, relationships between supplier and end user are paramount.

Unlike large water treatment plants, smaller buyers don't spec products through EPCs. Instead, they rely on companies with a local distribution network that can sell, install and service complete solutions featuring mixers, metering pumps, analytics flow meters, chemical tanks and piping systems. Milton Roy's (and LMI's) distributors take great pride in servicing smaller systems in rural areas.



## Mixing Solutions beyond Oil & Water

While this white paper focuses on mixers for oil & water, Milton Roy has been providing mixing technology to customers in numerous industries for more than 100 years. Milton Roy's mixing technology has been used by customers around the globe in various markets, including:

- **Chemical Industry** – for mixing and storage of chemical products
- **General Industry** – for agitation of bitumen, painting, inks, additives, adhesives, textiles and lubricants
- **Pharmaceuticals** – for additives injection, dilution and storage for numerous applications
- **Food & Beverage** - to mix additives for injection, dilution and storage for numerous applications.
- **Mining** – for leach applications, rock slurry tank, floatation and various reactor duties.



Milton Roy's comprehensive portfolio of mixers can address mixing applications for any industry. When it comes to general blending, homogenization, dissolution, suspension, coagulation, flocculation, pH adjustment, dewatering or any other mixing requirement, Milton Roy has the application expertise, and multiple product options (top entry, side entry, different blade configurations and numerous motor/gear box options) to provide the right mixer for the job.

For decades, Milton Roy has worked with the largest global EPCs, and hundreds of smaller engineering firms & distributors to accommodate any customer, and to provide prompt & efficient aftermarket support and maintenance.

Contact Milton Roy today – and learn more about increasing the productivity of your mixing applications while boosting your bottom line in the process.

Visit: <http://www.miltonroymixing.com>



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