



PIELKENROOD PHYSICAL/ CHEMICAL TREATMENT

**Your trusted partner in oil/water separation
and wastewater treatment since 1965**

Upstream

- Complete produced water treatment plants to injection or disposal
- Oil de-watering separators
- Chemical injection skids
- Sand handling solutions

Downstream

- Tank terminal WWTP
- Petrochemical plant WWTP
- Refinery WWTP
- Port receiving station WWTP
- pH neutralization plants
- Desalter blow-down treatment

Municipal

- Sewage treatment
- Drinking water preparation

Technologies

- Oil water separators (CPI)
- Liquid/solids separators
- Physical chemical treatment
- Dissolved air/gas flotation
- SBR biological treatment
- MSBR biological treatment
- Nutshell filters
- Multimedia filters
- Activated carbon filters
- Stripping columns
- UVC reactors
- Advanced oxidation processes
- Enzymatic treatment
- Integrated water treatment plants
- Zero Liquid Discharge plants

Competencies

- Design
- Engineering
- Procurement
- Project management
- Fabrication
- Inspections and testing
- Site installation
- Commissioning and start-up
- Operation
- Maintenance
- Rental services
- Financing
- Turnkey projects

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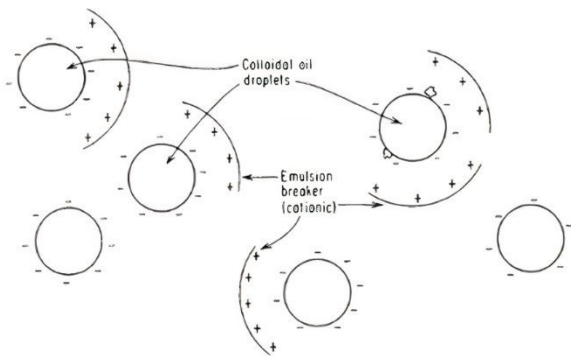


Coagulation and flocculation

Tiny oil droplets and solids particles are hard to remove by gravity. They remain in suspension. This applies in particular to colloid dispersions and emulsions.

We need to let these droplets and particles collide with each other to agglomerate into larger droplets and particles, which are easier to remove by means of settling or flotation.

However, because of their electrical charge, the droplets and particles repel each other. As a result, they remain in suspension. To destabilize the suspension, we need to neutralize the electrical charge by dosing a coagulant. The most common coagulants are aluminum and iron salts, such as aluminum and ferric chloride. These coagulants have large charges.



After destabilization, the small particles can start to agglomerate into larger ones. Stirring or mixing speeds up this process because it increases the number of collisions between particles.

Coagulants are most effective at a pH between 4.5 and 7. In case the pH of the wastewater is higher than 7, it must be lowered by dosing an acid. Generally the dosing of a coagulant will further reduce the pH.

To facilitate separation, the particles resulting from the coagulation process need to be conglomerated into larger aggregates that can be removed from the wastewater.

This is achieved by dosing a flocculant, usually a polyelectrolyte, which produce a so-called 'sweeping floc mechanism'. There are different polyelectrolytes: anionic, cationic and neutral ones.

Again, stirring or mixing promotes the flocculation process.

There is no specific pH requirement for the dosing of a flocculant. The pH only has to be

corrected if that is required for downstream processes or discharge.

By means of a JAR test, we establish which chemicals and dosings rates are most suitable.

Continuously Stirred Tank Reactors

Coagulation and flocculation are usually performed in flocculators. A common type of flocculator is the continuously stirred tank reactor or CSTR.

CSTRs typically consist of a coagulation compartment followed by two flocculation compartments, one for rapid mixing and one for slow mixing. All compartments are equipped with an agitator. Sometimes the coagulation tank is preceded by a pH adjustment tank.

CSTRs have some inherent flaws and drawbacks that are the cause of their poor performance:

- Short-circuiting of flows through the tanks;
- Back mixing;
- Wide residence time distribution;
- Largely uncontrollable velocity gradients, in particular around the stirrer blades.

These shortcomings can only partly be compensated by overdosing chemicals. This results in a higher operating cost together with a reduced downstream separation efficiency.

Coiled Pipe Reactors

Pielkenrood was one of the first to introduce the Coiled Pipe Reactor (CPR) for coagulation and flocculation on an industrial scale in 1977.

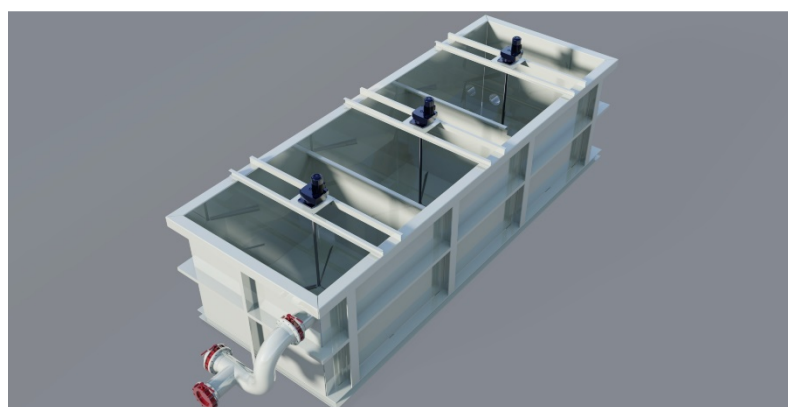
The main advantages of the Pielkenrood CPR:

- No moving parts, resulting in lower operating cost (no power consumption and considerably less maintenance) and less downtime;
- No short-circuiting or backmixing;
- Optimal mixing control and narrow residence time distribution allows for less chemical dosing, further saving on operational cost.

The CPR is a very sustainable choice.



Large CPR with GRE-CST (conductive) pipes. This CPR is part of a produced water treatment plant with a capacity of 250 m³/h



Typical CSTR with three chambers



CPR as part of a refinery waste water treatment plant. The material of construction is GRE-CST (conductive)



Smaller CPR under construction. This one was designed for a flow rate of 10 m³/h. The material of construction is PP.



CPRs can be constructed of various materials, such as HDPE, PP, GRE, carbon steel or stainless steel.

Working principle

A CPR is a static reactor consisting of a length of pipe of different diameters. For practical reasons, the pipes are arranged in coils and installed on a support frame.

The CPR has several dosing points with chemical injection needles with an integrated check valves. Just behind the dosing points, inline orifices create flash mixing of the chemicals. Rapid, medium and slow mixing is effected by the mixing energy, derived from velocity gradients generated by the water flowing through the pipes.

Coagulation and subsequent peri-kinetic flocculation are rapidly progressing processes that require relatively high mixing energy. That is why the first coils have pipes with a smaller diameter, which cause a high flow velocity and high velocity gradients.

For the ensuing ortho-kinetic flocculation, medium and slow mixing energy is required. This is achieved by successively increasing the pipe diameters, thus decreasing the flow velocity and velocity gradients.

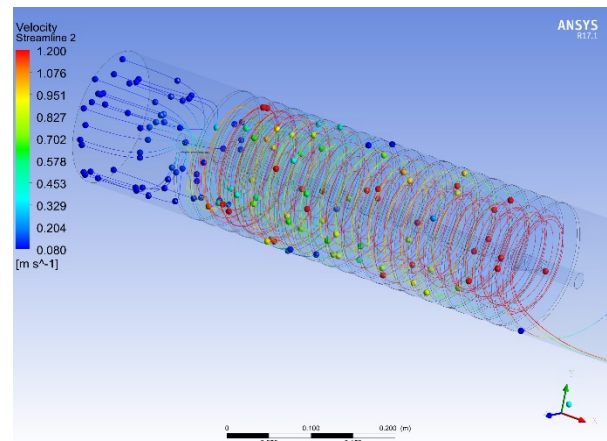
Such a tapered velocity profile cannot be accurately achieved with CSTRs.

Furthermore, the CPR has the characteristics of a plug flow reactor with strictly controlled velocity gradients. This means that no short-circuiting and back mixing occurs, allowing for a narrow residence time distribution.

Optimal coagulation and flocculation can be realized without overdosing chemicals. This significantly contributes to the efficiency of the downstream flotation or clarification process.

To be able to verify the efficiency of chemical dosing, our CPRs have samples points in front of and behind each dosing point.

CPRs don't come in standard sizes because each project is different in terms of flow rate, composition of the influent and design conditions. The length and diameters of the pipes are carefully calculated for optimal performance. We use CFD to validate the flow patterns through the reactors.



Other applications

We also use CPRs for other applications in which chemicals have to be dosed. For example, pH neutralization and H_2O_2 oxidation.

Chemical storage tanks

For storage of coagulants, acids and caustic, we supply double wall HDPE, PP or GRP tanks. Typically, the tanks have 30 days storage capacity. Our tanks can be provided with vacuum leak detection, level indicators and overflow protection.

Each tank is provided with a separate fill cabinet. The fill cabinet has a solenoid operated valve mounted in the tank fill line and is equipped with leak detection.

Adjacent to the fill cabinet a local switch panel is installed. The switch panel receives signals from the tank level instrument, from the vacuum leak detection system and from the fill cabinet leak detection. When during filling of the tank the 90% full point is reached a visible and audible alarm is triggered. When the 95% full point is reached the solenoid valve will close automatically.

Polyelectrolyte make-up unit

The polyelectrolyte make-up unit is a fully automatic two or three chamber flow through unit, suitable for liquid polyelectrolyte concentrate. The unit includes a high pressure peristaltic polymer concentrate feed pump, a preparation tank with a high speed mixer and a dosing tank with a slow speed mixer, a water supply system with pressure reducing valve, pressure gauge, solenoid valve and flow meter, level sensors for over fill and dry run protection and a local control panel.



Dosing points with orifices and samples points



HDPE chemical storage tank during FAT testing



Dosing cabinet with two dosing piping, calibration pot, piping, valves and instrumentation pre-installed



The unit is provided with a local control panel which includes a dedicated PLC. Controls include:

- automatic shutdown in case of water and/or polymer concentrate shortage;
- proportional water/polymer supply;
- step-less pre-selection of the make-up concentration.

Chemical dosing cabinets or skids

Each chemical has its own dedicated dosing system with two dosing pumps, one duty and one stand-by. The dosing pumps are double diaphragm metering pumps.

Each pump has a suction strainer, a safety valve for over pressure protection and a pressure gauge. The common suction line is fitted with a calibration pot and the common discharge has a check valve.

The dosing pumps together with ancillary piping, valves, pulsation dampeners, calibration pot and wiring are installed in pre-fabricated HDPE cabinets or skids with integrated drip pan.

Plant air connections are provided for in order to air flush the dosing piping when so required for plant maintenance.

Flow rate adjustment of the dosing is automatic and based on the output of the pH and flow transmitters. Adjustment of the dosing rates is effected by means of variable speed drive motors.

Accessories

If required, we can supply the following accessories:

- CPR feed pumps
- Interconnecting piping between the chemical storage tanks, the dosing cabinets/skids and the CPR;
- Valves;
- Instrumentation, such as level transmitters, pH transmitters and flow transmitters.

We respect your approved vendor list and of course, we follow international engineering and project-specific standards. For example API or ISO pumps and ATEX certified instruments and electric drives.

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