Agriculture and Agri-Food Canada
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Water Quality Matters

On-Farm Coagulation

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COAGULATION

Coagulation is the process of adding chemicals to water to make dissolved and suspended particles bind together, forming larger particles that will settle out of the water as a sludge. Coagulation is a safe and effective method of water treatment, commonly used in municipal drinking water treatment. It is suitable for treating the organic-rich water often found in Prairie surface water sources, such as dugouts.

WHY COAGULATE?

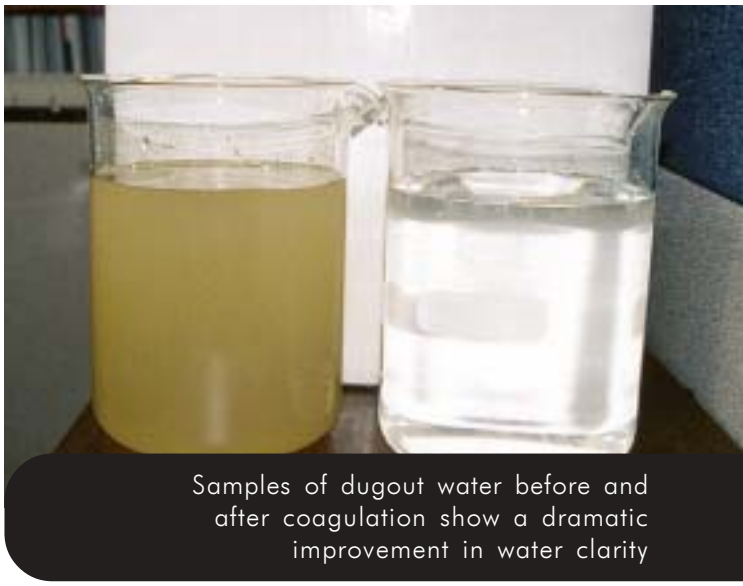
Coagulation can be a simple and inexpensive way to improve the quality of farm water. This may have benefits for:

- household use (including improved operation of commercial treatment systems);
- mixing of farm chemicals;
- livestock watering; or
- food processing.

HOW COAGULATION IMPROVES WATER QUALITY

Coagulation can improve the quality of water by:

- reducing the dissolved organic carbon (DOC) concentration by approximately 60%. This improves taste and odour, makes the water safer for chlorination, and makes the water easier to treat for domestic purposes. DOC removal also improves water quality for agricultural uses, such as livestock watering;



Samples of dugout water before and after coagulation show a dramatic improvement in water clarity

- reducing the number of suspended particles in the water, which makes the water easier to treat for other purposes such as domestic use and provides a high quality of water for farm chemical spraying;
- reducing colour by over 80%, which makes the water more aesthetically appealing;
- reducing the dissolved phosphate concentrations by approximately 90%, which helps reduce algae blooms, including toxic blue-green algae; and
- removing iron and manganese which improves the taste, eliminates stains on laundry and fixtures, and eliminates coatings on pipes.

COAGULATION OPTIONS

Coagulation can be used to treat water from rivers, lakes or reservoirs. Coagulation can be performed directly in a dugout, in a coagulation cell, or with a commercial coagulation system. A coagulation cell is a small,

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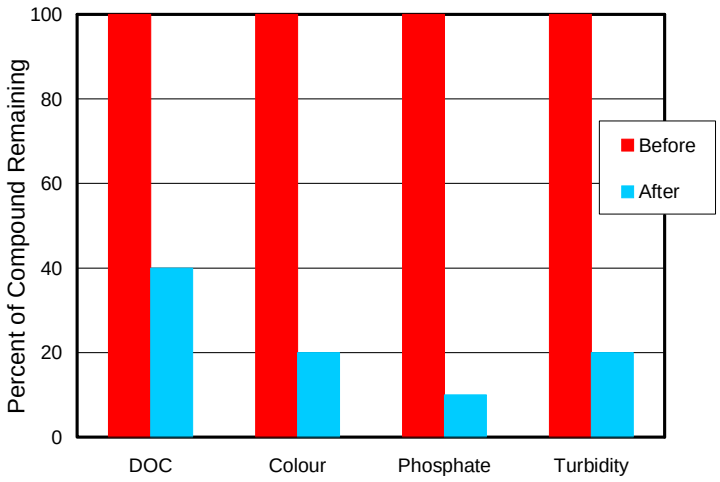
Typical Benefits of Coagulation



constructed reservoir that is used to store and treat water about twice per year; it is sized to allow use of all the treated water. A commercial coagulation system uses a tank for treating water on a daily basis.

Dugout coagulation is recommended as a temporary solution to water quality problems in dugouts. Because poor quality surface runoff flows into the dugout, repeated applications are required. The large volume of dugouts means high chemical costs, usually ranging between $200 and $800 per treatment. If the dugout is not carefully managed, repeated treatments could cause elevated chemical residuals.

A coagulation cell has an inverted pyramid shape. Cells for household water supplies are designed to hold approximately 250,000 litres or 55,000 gallons (equivalent to about six months of domestic water needs). Of course, larger cells can be built for other agricultural uses.

Dugout coagulation can be achieved by mooring the boat and pumping chemicals downstream of the boat motor propeller

A bank is built around the cell to prevent contamination from any surface runoff. An unlined coagulation cell without plumbing will cost about $1,500. A lined cell complete with plumbing will cost about $6,000. Household water cells are treated once in the spring and once in the fall at a cost of under $100 per treatment.

The commercial coagulation system uses a batch coagulation process. Water is treated every three hours until the storage tank is full. This system costs about $6,000 and is easy to operate, but requires the use of special chemicals.

Coagulation cells are filled by pumping water from the dugout, river or lake to the cell

CHEMICALS USED FOR COAGULATION

Aluminum sulphate and ferric chloride are the primary coagulant chemicals used for drinking water treatment.

Powdered activated carbon (PAC), a coagulation aid, can be used in coagulation cells to enhance removal of organic compounds that cause taste and odor problems.

Polyaluminum chloride (or other polymerized chemicals) are used for specific applications such as those required by commercial coagulation systems.

Each coagulant chemical has strengths and weaknesses. The most important considerations in choosing a chemical are the treatment method, desired water quality and the expected water use.

See “Chemicals for On-Farm Coagulation” publication for further details.

The commercial coagulation system uses a cylindirical mixing and settling tank, chemical injector pump, controller and holding tank to treat the water

THE COAGULATION TREATMENT PROCEDURE

When treating a dugout or a cell, the following steps must be taken:

1. Calculate the volume of water to be treated.
2. Complete a beaker test on a one litre sample to determine the chemical dosage.
3. Calculate the total amount of coagulation chemical to be used.
4. Mix the water adequately.
5. Add the chemical and continue mixing the water for a sufficient time.
6. Monitor the pH and alkalinity to prevent overdosing.
7. Stop mixing and allow the water to settle.

When using a commercial coagulation system, follow the operation and maintenance procedures recommended by the manufacturer. Treated water should be tested at least twice per year.

See “How to Coagulate Your Dugout or Cell” publication for further details.

HANDLING THE SLUDGE

A small volume of sludge is produced after coagulation treatment. In a dugout, the sludge can be left at the bottom of the dugout.

In a coagulation cell, the sludge should be removed annually. Fall is the best time to remove sludge. The sludge can be safely applied on an adjacent field or pasture. Studies have shown no crop yield reduction or detectable residues in the crop following heavy sludge application rates.

Aluminum sulphate and ferric chloride are the primary coagulant chemicals used in coagulation cells

THE LIMITATIONS OF ON-FARM COAGULATION

Conditions that limit the effectiveness of coagulation treatment, or deteriorate water quality after treatment include the following:

- animal, fish or other aquatic activity in a coagulated dugout or cell;
- presence of an algae bloom;
- inadequate or excessive dosage;

- inadequate or excessive alkalinity; and
- very poor raw water quality.

By itself, coagulation treatment does not make water safe for drinking. It is a treatment process that is very effective when managed properly, and used in conjunction with other processes when higher quality water is desired.

THE BIG PICTURE

Water quality affects the agri-food sector in numerous ways. Poor water quality can:

- impact livestock production, pesticide application, and domestic use;
- affect animal health and weight gain;
- cause watering systems to fail;
- reduce herbicide performance and plug spray nozzles; or
- stain fixtures and cause taste and odour problems.

Coagulation is one of many treatment options available to improve surface water quality. Biological treatment systems and filtration are other options. These various treatment options, along with additional components, can provide water to meet the specific requirements of the agriculture and agri-food sector.

Coagulation is best suited to treating surface water for livestock consumption, chemical mixing and domestic use. Dugout coagulation has proven very effective to remediate old dugouts, or dugouts affected by flooding. Farmers who require good quality surface water for mixing with herbicides commonly use dugout coagulation as a treatment method. Coagulation has also been used experimentally, to supply higher quality water for cattle and hogs. It may also be useful for applications such as food processing and drip irrigation.

Coagulation cells, as well as the commercial system, are valued for supplying improved water quality for domestic use. In some cases, such as chemical mixing, it may be the only treatment process required. In other cases, such as food processing, it may proceed other treatment processes.

For further information on rural Prairie water quality and treatment technology:

- read the other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA website at www.agr.gc.ca/pfra;
- get a copy of "Rural Prairie Water Quality: Searching for Solutions for On-Farm Users" available from PFRA;
- read Prairie Water News, available from PFRA, or on the Internet at www.quantumlynx.com/water; or
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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