



IRON OCHRE CONTROL METHODS - A Literature Review -

The purpose of this note is to summarize and describe possible methods to control iron ochre. The following four papers were reviewed:

FORD, HARRY W. and WILLIAM E. ALTERMATT, Hancor Bio-Flow Tubing – An Aid Against Biological Clogging of Underdrains, Hancor Inc., 401 Olive St., Findly, Ohio, 45840. MARCH, 1986

FORD, HARRY W. Iron Ochre and Related Sludge Deposits in Subsurface Drain Lines. Circular 671, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 1985

KUNTZE, HERBERT, Iron Clogging in Soils and Pipes – Analysis and Treatment. Pitman Publishing Inc. 1020 Plain Street, Marshfield, M.A., 1982

VAIGJAN, D. WHEATLEY, R.E. and B.G. ORD. Removal of Ferrous Iron from Field Drainage Waters by Conifer Bark, Journal of Soil Sciences. 35:149-153, 1984

To better understand the material in this note, the reader should first review the BCMAF Factsheet. "[Iron Ochre Problems in Agricultural Drains](#)".

The following are three possible approaches in dealing with iron ochre problems:

1. Precipitation of Iron in the Soil.
2. Retardation of Clogging in the Drains.
3. Ochre Removal.

1. PROMOTION OF OXIDATION AND PRECIPITATION OF IRON IN THE SOIL

The objective of this approach is to cause the precipitation of iron in the soil before it reaches the drainpipe. This involves techniques which alter the

chemistry of the soil or retard the iron within a material before it can enter the drain. The pH and electric potential of the soil are affected when the soil chemistry is altered. It is these two parameters that control the availability of iron for iron ochre formation.

1.1 Subsoil Loosening

Drainage of a waterlogged soil depends upon the amount of pores present. Two types of pores exist within the soil. Primary pores depend upon the particle size, i.e., silt, clay and sand have progressively bigger particles. Secondary pores result from good soil management when the soil is kept loose and friable.

An objective of subsoil loosening is to increase the amount of oxygen in the soil, which will cause

oxidation of the ferrous iron to a non-mobile ferric iron state. At any time, the reverse reaction can occur should the soil be flooded, as the iron is slow to age to a stable form.

Subsoil loosening can only be effective if the clay content of the soil is over 30% and the moisture content is below the plastic range.

Due to the wet winters in the Fraser Valley, this technique will only assist in slowing down the rate at which iron will enter the drains, not eliminate it. Therefore, the method is only useful when it has been determined that the clogging hazard is temporary.

Prior drainage of the area by open ditches or loosening and drainage of the subsoil by mole drainage has also been shown to be effective. Subsoil loosening is important not only the control of iron ochre, but in maintaining good hydraulic conductivity and plant root growth.

1.2 Surface Liming

Iron in the soil is more mobile at lower pH than higher because it is at a lower oxidation potential. Calcium in the form of lime will promote further oxidation of the iron.

Tests done in Germany showed the heavier the lime application, the greater the amount of iron that is immobilized. Continual checking of the pH of the whole soil profile, with frequent reliming, is important to the success of this approach. Losses of up to 0.8 tonne/ha/yr of lime can occur in humid climates.

The higher the pH, the less the amount of soluble iron that will usually be present in the ground water. Research in Florida found that it would be necessary to raise to soil pH to 8.2 to effectively control the ochre.

Drawbacks to this approach include the immobilization of phosphorus and other trace elements, crop tolerance to the higher pH and the expense of the large amount of lime. Data from Germany has also shown that high lime applications can reduce the permeability of the soil.

1.3 Liming of Drain Trenches

Because of the cost and effect of heavily liming, entire fields, liming of just drain trenches has been investigated as to its effectiveness. Lime requirements can be cut down to 10% of that required in broadcast liming. Results show that initial relief from clogging occurs, but the long-term effect is to lower the permeability of the drain trench soil because of precipitation of iron in the soil surrounding the drain.

1.4 Coarse Filter Materials

Coarse filter materials include gravel, bulky organic material such as chopped branches and glass fiber mats. The material assists by creating an additional aeration space around the drain if the water table is below it and by trapping the iron in the material. Many investigators report that the permeability of the filter material decreases considerably within 2 to 12 years. Organic materials become blackened and decrease in permeability due to ferric sulphate and inorganic filters become clogged with ferric hydroxide. Coarse gravel when dug up after a number of years shows little ochre accumulation; proving to be ineffective as a filter for preventing iron from entering the drain.

Most synthetic filters installed as a sock around the pipe to prevent sand clogging are subject to clogging themselves. Clogging in the pipe will first occur in the slots and valleys of the perforations and later bacterial growth will plug the voids of the socks.

In general, filters are successful in trapping the iron, but will in turn become clogged thereby reducing the permeability around the drain. Unless the filter material is replaced regularly or cleaned in some manner which is not practical, they do not appear to be effective in the long term.

SUMMARY OF APPROACH 1

Review of the preceding methods show some are impractical, while others only offer temporary or marginal relief.

Subsoiling has been shown to be effective in some cases, although subsequent flooding of the soil will allow iron to be released.

Broadcast liming is an expensive method to carry out on a continual basis and is not recommended.

Liming of drain trenches will only result in clogged soil and backfill material around the pipe.

Attempting to trap the iron in a filter material is ineffective because the material itself will become clogged. If filter or backfill material is required in suspected iron ochre areas, only coarse rock should be used.

Consequently, the only practical solution with this approach is subsoiling. This will only work if the clay content of the soil is above 30% and the soil has a low to medium moisture content.

2. RETARDATION OF CLOGGING IN THE DRAIN

Retardation of the clogging process in the drain attempts to deal with the ochre problem through the design of the drainage system. This approach is required on sites where it has been determined that the clogging problem is long term.

2.1 Grade

The amount of ochre in the lateral usually increases from top to the outlet. Tests appear to indicate that given the range of grades permissible in a lateral, there is still sufficient opportunity for the ochre to form. While this appears to be the case, an increased grade will enhance the self-flushing action in addition to low pressure cleaning which depends upon the grade. Low pressure cleaning is described in Section 3.1.

Wherever the drainage design will accommodate an increased grade and still meet the maximum and minimum pipe grades along with depth of cover requirements, the maximum possible grade should be chosen.

While this appears to be the case, several authors have suggested minimum grades for self-cleaning. These recommendations range from 0.5% to 4.4%.

2.2 Pipe Material

Iron ochre will stick to plastic drainpipe with about 20% more force than to a fired clay tile. Experiments have also shown that compounds mixed into the plastic of a pipe increase or decrease the ability of ochre to stick to it. For example, tin

compounds in the plastic made the ochre stick less while lead salts make it adhere nine times greater.

Ochre becomes more adhesive as it ages and with lowered temperatures. Cleaning of drains in iron ochre areas should be done yearly as aged ochre becomes more difficult to remove.

Above 15° C there is virtually no temperature dependence so flushing with hot water is not necessary.

2.3 Inlet Hole Dimensions

The smaller the width of the inlet slit of the pipe, the longer a drop of water hanging at the hole takes to detach. Higher pressure over the droplet that forms about the hole is required to force the water into the pipe. The longer the water drop hangs, the more oxidation will occur because of the large surface area exposed to air.

Slits with widths less than 0.8 mm will clog quickly while large slits will allow soil particles to enter. From model tests, a minimum width of 1.4 mm is recommended for inlet holes of drains subject to iron clogging. According to German recommendations, the following maximum slit widths are permissible (depending on soil type) for plastic pipes.

With drain filter 2.0 mm
Without drain filter 1.5 mm

Evidence also shows that poorly cut slits with frayed edges allow ochre to adhere much better thereby quickly plugging the slit. Some investigations have been done on pipe with a combination of slits and cleanly drilled holes. The ochre will quickly bridge the slits but has much more difficulty in bridging the holes which ranged from 4.8 mm to 12.7 mm in diameter.

Preliminary results on drain tile with holes rather than slits appear to indicate that they perform much better than the conventional tile with slits only.

2.4 Submerged Outlets

Submergence of drain outlets is an old practice of controlling iron ochre. Several prerequisites must be met for this practice to work satisfactorily.

1. The total volume of the mains and laterals must be filled with water. This means very deep drains, small drainage systems or individual laterals ending in a ditch.
2. The outlet must be kept permanently under water. If ditch waters fluctuate seasonally, a water control structure must be constructed to maintain a water level above the outlet.
3. Because of backflooding, there will be a small drag force exerted on the tile. Backflooding will also reduce the effectiveness of the drainage system by requiring a head differential to force water through the tiles.

Despite the fact that the top third of the lateral can be exposed to air and that percolation water from the soil surface contains oxygen, the degree of iron clogging remains low. Test results have shown a 20% reduction in ochre deposition in the draintile.

A drawback of this method is that high levels of ferrous iron are maintained in the soil due to the conditions that exist. The soil contains more water and increased siltation occurs due to minimal flushing action.

2.5 Iron Complex Formation

Backfill with materials containing phenolic and tanni compounds such as bark, have shown good success in causing iron complex formation. These compounds prevent the iron from being oxidized into iron ochre. Other types of control can be achieved by laying a copper wire down the pipe and backfill with industrial slag. All these methods contaminate the discharge water with chemicals which are generally at unacceptable levels.

Bark filled bags placed so that water in the drain must flow through them, have shown good success in reducing the amount of ochre in the drain. This technique will greatly reduce the chemical levels created by entire backfilling of the line with bark, however, no information is available detailing what concentration the phenolic compounds are in the drainage waters. Conifer bark aged for 12 months has a lower amount of soluble phenols as opposed to fresh bark. This work has been done in Scotland, no work has been done in B.C. using bark from native species, to date.

2.6 Bactericidal Drains and Filters

A great deal of ochre is produced through bacterial action. Control of the bacteria may be a means of controlling the ochre problem. Bactericide, a compound which will kill bacteria, has been soaked into the porous clay tiles before installation in the ground. Tests have shown that this technique is largely ineffective because the bactericide cannot be retained in the tile for extended periods of time.

Some new pipe with a biocide, a compound killing all micro-organisms, mixed into the plastic during manufacturing has shown some success in controlling ochre. Only three years of tests have been performed to date, so the long-term success of the biocide is still uncertain. This particular pipe meets all environmental standards in the US but has not yet been evaluated in Canada.

A bactericidal filter generally consists of a backfill material containing chemicals. Industrial slag or bark which contains phenols have been tried. However, environmental restrictions on water quality prevent this approach from being used.

SUMMARY OF APPROACH 2

Review of techniques for controlling iron ochre within the drainage system have shown several useful methods and eliminated others. Increased pipe grade will assist the flushing of ochre from a pipe. Different pipe material affecting the ability of ochre to stick to it is another means of controlling the ochre problem but, the availability and cost of different materials in British Columbia essentially dictate the use of standard corrugated plastic tubing. Drain pipe with large circular holes, rather than slits, appear to be one of the best ways of living with the ochre problem. Backflooding of draintiles can reduce ochre accumulation by 20%.

Most of the chemical control methods are not advised. The bark bag technique shows promise in controlling iron ochre but research is required to determine if the level of chemical leachate is acceptable. The newly developed pipe with biocide also appears to show promise in control of ochre.

3. OCHRE REMOVAL

Previous techniques discussed will achieve partial success in controlling iron ochre. Since long-term

freedom from the problem is not possible, physical removal of the ochre is required at some point

3.1 Low Pressure Cleaning

Low pressure removal of ochre is feasible provided the ochre in the pipe is fresh and gelatinous. An effective method has been developed using a vacuum tanker intended for liquid manure spreading.

When the drainage system is filled with water, the pipe from the tanker is removed from the outlet allowing the system to flush. This will remove a great deal of ochre, however, a second flushing is recommended for better effect.

The relative effectiveness of the flushing will depend on the drag force of the water, which in turn depends upon the pipe grade. A steeper grade pipe will enhance the flushing action.

Flushing on an annual basis can keep a drainage system in good working order even in badly clogged sites.

Care must be taken so that too much pressure isn't applied to the system as pipe joints could blow out. This method is useful where laterals are connected to a main and are not accessible from an open ditch.

3.2 High Pressure Cleaning

High pressure cleaning is required if the ochre has aged and become firmly encrusted onto the tile. Individual drains must be cleaned from the outlet. A high-pressure nozzle with water spraying in a backwards direction propels the nozzle up inside the tile. Because of this type of operation, only straight lines or shallow bends can be cleaned. This method is more practical for laterals ending in an open ditch, otherwise, connections to main would have to be dug up. An alternative is to install a Y fitting on each lateral line near the main. A piece of tubing can then be angled up to the surface and capped and marked thus allowing easy access to the pipe. The length of drain is restricted because of the ability of the nozzle to pull the hose behind it.

Cleaning between corrugations require at least 690 kPa when the drain openings are holes. A pressure of 2756 kPa was found to remove only 30% of the ochre between corrugations when the openings are slits.

This is another reason why large slits should be used in ochre affected areas and why cleaning of many older installations are only partially successful.

Pressures up to 2756 kPa at the nozzle are suggested as the upper limit for sandy soils until more research is carried out. Too high a pressure will cause considerable damage to the envelope of material surrounding the pipe causing sand and gravel to be swept into the tile.

3.3 Chemical Cleaning

Persistent aged ochre may only be removed by acids or reduction agents. Fresh ochre can be dissolved with 10% hydrochloric acid, however, it must be added in excess to prevent reprecipitation of iron oxide hydrate.

As the ochre ages, it's solubility in hydrochloric acid decreases so it is often difficult to estimate the required amount of acid. Since the drains carry water, additional dilution will occur upon introduction to the drain.

The general procedure used is to pump the acid into the drain and dam it up for several hours. The acid-ochre suspension is then repumped into tankwagons and the procedure is repeated with fresh acid. A succeeding flush with water is also required to remove acid residue. All the flushing material must then be disposed of at a safe chemical waste disposal facility.

Sulfuric and Sulfamic acids have also been used with success. Acid cleaning has been used extensively in Southern California but has now been replaced by high pressure cleaning. No acid should be used on drains with synthetic filters.

Chemical cleaning by the above methods is not recommended under any conditions by the BCMAF, due to its dangerous potential.

4. CONCLUSIONS

Many techniques tried around the world have been discussed and each has varying degrees of success. It is obvious no single technique will cure all problems and that it is necessary to employ a combination of techniques and to perform regular maintenance on the system. The following are

several worthwhile procedures that can be followed to minimize ochre problems.

1. Laterals should preferably drain into an open ditch rather than a main collector because often only a small area within a field can be problem causing. This will prevent clogging of the entire system and reduce the time required in cleaning.
2. If laterals must join to a main collector, they should be installed with Y connections to the main to allow jet cleaning.
3. Good soil structure is important for many different reasons. It will reduce ochre problems by allowing fast percolation of water through the soil thereby minimizing waterlogged conditions and maintaining good aeration, therefore promoting oxidation of iron in the soil
4. Avoid using backfill materials other than coarse gravel as other materials will eventually clog.
5. Back flooding of the drain tile can reduce ochre clogging by about 20%.
6. Flushing should be done within the first year rather than waiting for the pipe to severely clog. Ochre is much easier to remove when it has not aged.
7. Drain tubing with large slits or preferably round holes will resist clogging longer than small holes and slits. Drain tubing with cleanly cut holes and slits should be used as ochre will preferentially stick to frayed edges.
8. Use of the drainpipe with biocide will assist in controlling the ochre during the period of severe clogging after installation.

Preliminary test results on the draintile with biocide show some success, but additional investigations are required before it can be recommended for use.
9. Increased pipe grades will enhance the self-cleaning process and make low-pressure cleaning more effective.

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