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Moringa oleifera at pilot/full scale

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Abstract

Crushed seeds of the tree Moringa oleifera Lam. (M.oleifera) are a viable replacement coagulant for proprietary chemicals such as aluminium sulphate (alum) in developing countries. The tree is a multi-provider that grows pantropically and its distribution in Africa and various vernacular names are noted.

This paper presents results from pilot scale treatment trials carried out at Thyolo in southern Malawi early in 1993. The pilot works utilised for the study, situated on the site of an existing Ministry of Works operated treatment plant, comprises a header/flash mixing tank, gravel bed flocculators, plain horizontal flow sedimentation tank and a rapid gravity filter. The system has a nominal flow rate of 1 m^3/hr. Inlet raw water turbidities were maintained at around 400 NTU throughout the six week study. Over 90% removal of turbidity was achieved by effective floc formation and sedimentation. Floc carry over was susequently removed in the filter producing a final water consistently less than the WHO guideline value of 5 NTU.

Results from full scale trials on the existing Ministry of Works operated treatment plant are also presented. Alum, the normal coagulant used, was replaced with M.oleifera seed solution and comparable performance was observed. This is the first time that M.oleifera has been used as a primary coagulant at this scale (flow rate 16 m^3/hr).

Introduction

Since 1986 the Environmental Engineering Group at the University of Leicester have been examining crushed seed powder of the tree Moringa oleifera Lam. (M.oleifera) as potential full or partial replacements for proprietary chemical coagulants in the treatment of surface waters in developing countries. M.oleifera is a native of the sub-himalayan tracts of N.W.India, Pakistan and Afghanistan and indigenous to many areas of Africa, South America and Asia. Various vernacular terms for the tree associated with Africa include (Jahn, 1986):

Nigeria - Adagba Malero
Burkina Faso - Argentiga/La-Banyu
Malawi - Chamwamba/Kangaluni/Sangoa
Ghana - Ewe Babatsi/Ewe Yevuti
Kenya - Mborongi
Tanzania - Mlonge/Mronge
Gambia - Neberdayo

The seed pods are allowed to dry naturally on the tree prior to harvesting. The seeds are easily shelled, crushed and sieved using traditional techniques employed for the production of maize flour. Dosing solutions are generally prepared as 1-3% solutions. The full scale trial reported was dosed with a 5% seed solution due to the limited capacity of the peristaltic dosing pumps available. The crushed seed powder, when mixed with water, yields water soluble proteins that possess a net positive charge. The solution acts as a natural cationic polyelectrolyte during treatment (Sutherland, Folkard and Grant, 1990).

In addition to the use of the seeds as a coagulant, the seeds, pods, flowers and leaves are used for a wide range of other purposes from foodstuffs to traditional medicine to oil production (Jahn 1986).

Pilot plant

The pilot plant consists of a header/mixing tank, gravel bed flocculation, plain horizontal sedimentation and rapid gravity filtration. Nominal flow rate through the plant is 1 m3/hr. Details of the works have been reported previously (Folkard, Sutherland and Grant, 1993). Seeds for the study had been collected and processed by the Forestry Research Institute of Malawi (FRIM). As previously stated raw water turbidities were maintained at around 400 NTU throughout the field study. Figure 1 shows a composite of the runs carried out. It can be seen that solids removal following flocculation and sedimentation is consistently in excess of 90% with filtered water quality remaining below the WHO guideline value of 5 NTU. Seed dose ranged from 75 - 250 mg/l dependent on the initial raw water turbidity. Figure 2 shows results obtained from a single 7 hour run.

Full scale trial

It had originally been planned to carry out full scale trials over a two week period. However, due to a lack of seed only a single 6 hour run using the seed was possible. The main works at Thyolo comprises two reactor clarifiers for primary solids removal followed by rapid gravity filters. Since installation in the 1970's both clarifiers have fallen into a state of disrepair. The impellers used to control the flow regime and to provide efficient mixing during flocculation are no longer operational. In addition, effective desludging can only be carried out manually, the time between desludging being judged by the operator as the sludge level indicators are inoperative. This can result in excessive sludge build up further reducing the efficiency of the works.

Due to the limited quantity of seed available for the trial only one of the clarifiers was used. The flow rate through the clarifier was determined to be 16 m^3/hr. The works was initially monitored with aluminium sulphate (alum) as the coagulant. The alum was then replaced with a suspension of M.oleifera. The coagulant was dosed via two peristaltic pumps into the nappe of the discharge from a 'V' notch weir in the raw water inlet box.

Figure 3 shows results obtained using alum as the coagulant. Figure 4 shows results obtained when alum was replaced with the seed solution. Comparing the two it can be seen that there is no deterioration in performance. Equivalent removals are achieved using the seed although at a higher dose than alum. The inherent inefficiency of the works is evident from the clarifier output turbidity. Excessive floc carry over was observed for both coagulants.

Conclusions

The pilot plant trials have demonstrated the effectiveness of the seed treatment for the clarification of high turbidity waters at 1 m^3/hr.

The full scale trial has demonstrated the viability of using the seed suspensions at 16 m^3/hr with equivalent performance to that of alum being achieved. Although higher seed doses were required studies are currently under way to improve processing techniques with the aim of producing a finer seed powder increasing the amount of active coagulant released.

Future work

Further full scale trials in Malawi are planned for January 1994. It is hoped that during this period demonstrations for interested parties from other developing countries will be arranged. Those interested in participating may receive further information from the authors.

Acknowledgements

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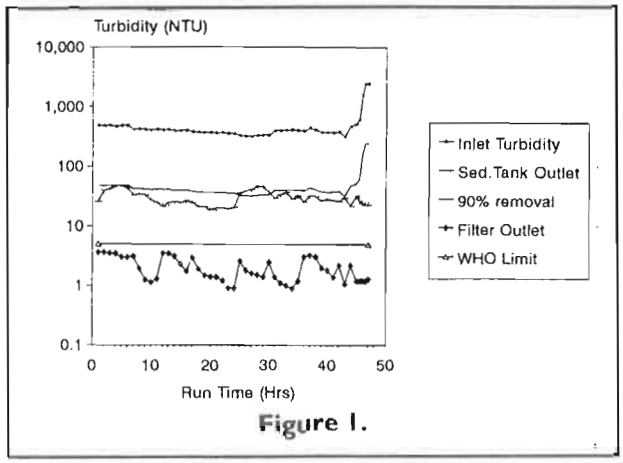
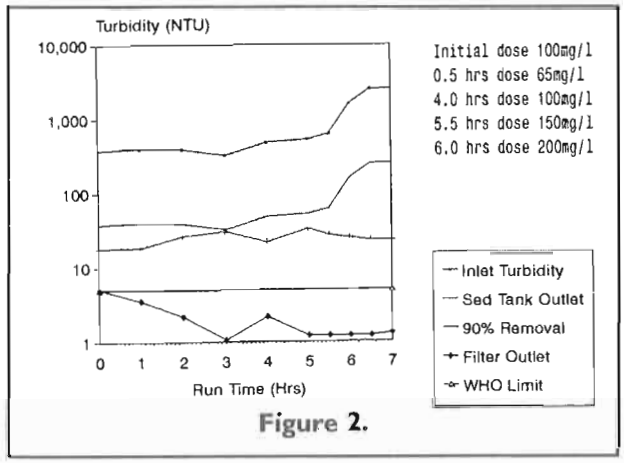


Figure 1.



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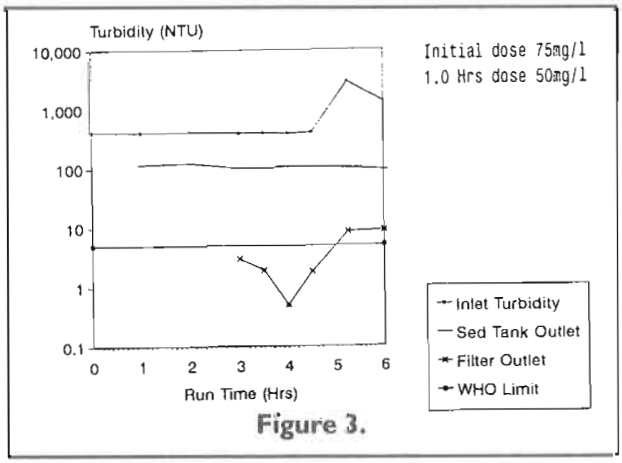

Figure 3.

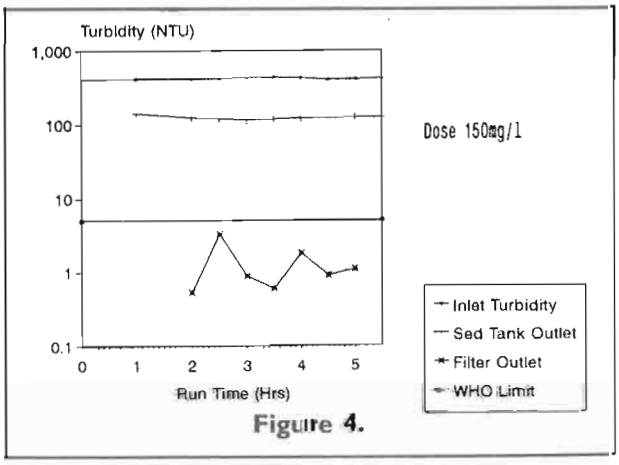

Figure 4.