

Treatment of wastewater from Arabica coffee processing



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PPP Project

"Improvement of Coffee Quality and Sustainability of Coffee Production in Vietnam"

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1. Introduction

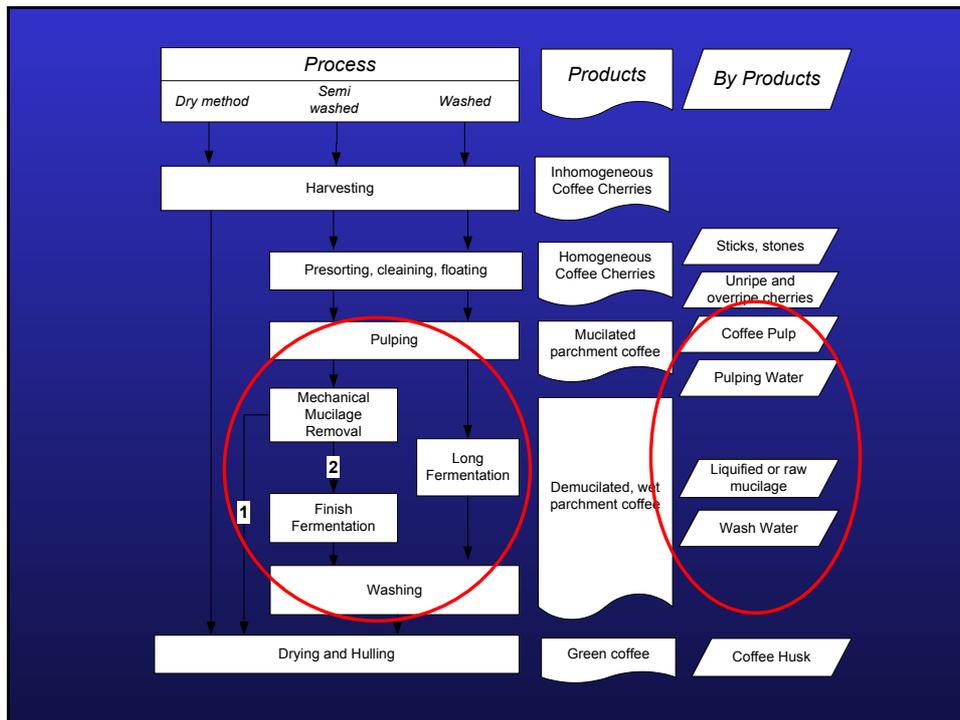
1. Introduction

- ☪ Environmental issues become more and more a topic internationally
- ☪ Also in Vietnam a rising awareness - high relevance for coffee processors especially under present plans to expand Arabica production
- ☪ In order to avoid environmental damage and health risks, characteristics and processes in waste water need to be understood
- ☪ Based on a good understanding, site specific treatment measures are to be taken

2. Coffee Wastewater Characteristics

2. Coffee Wastewater Characteristics (1)

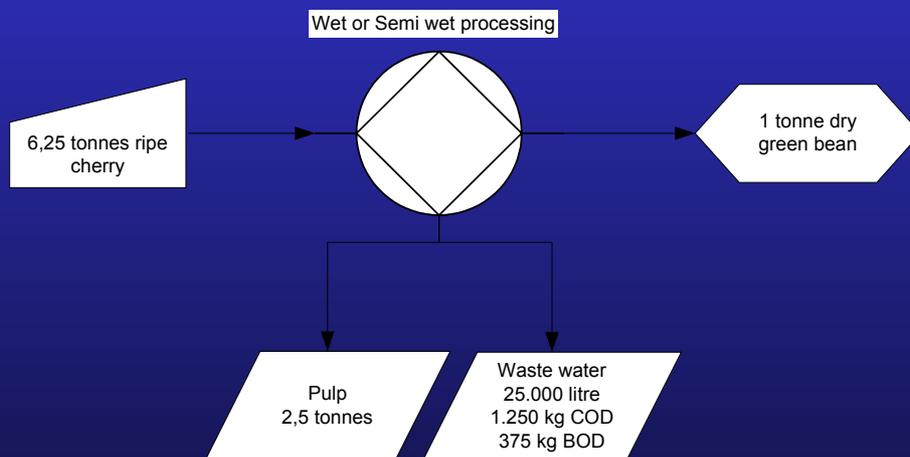
- Two main pollution streams can be identified, depending on processing technique applied
 - Effluents from pulpers: highly loaded with quickly fermenting sugars from breaking down pulp and parts of the mucilage
 - Effluents from fermentation tanks and/or mechanical mucilage removers: hydrolysed sugars from fermentation and/or thick pectin loaded effluent from mechanical mucilage removers
- Pectin and sugars are fermenting over alcohol to acetic or vinegar acid giving effluents giving acidity (pH between 3 and 4)
- In fermented wastewater, solids are coming out of solution
- Acid water appears clear - organic pollution load still extremely high
- Toxicity in coffee waste water no severe problem - only little tannins, polyphenolics and caffeine



2. Coffee Wastewater Characteristics (2)

- Organic pollution is measured in Chemical and Biological Oxygen Demand - BOD and COD
- BOD provides a figure on how much oxygen is needed by bacteria to break down the pollution load for in a given time (normally 5 days)
- Wastewater quantities: between 1 and 20 cubic metre/tonne fresh cherry
- Some figures:
 - Effluents from coffee processing: BOD between 8.000 and 20.000 mg/l
 - Pollution from 1 tonne of clean coffee equivalent to the daily pollution load of domestic sewage output of about 2.000 people!!!!

2. Coffee Wastewater Characteristics (3)





3. Effects on the Environment

3. Effects on the Environment

- 🍷 Combination of high acidity and high BOD widely exceeds self purification capacity of rivers and does not allow higher aquatic life!
- 🍷 Oxygen for biological breakdown exceeds oxygen in water leading to anaerobic conditions - bad smell through "rotting" and good growth conditions for health threatening bacteria when found in drinking water
- 🍷 Dark to black discoloration of rivers by tannins - no environmental risk but unsightly

4. Approaches to Treatment

4. Approaches to treatment (1)

--- Quantities ---

- ☉ In order to keep treatment facilities small and keep treatment costs low, water quantities must be reduced through water recycling of use water
- ☉ Recycling requires skills because temperature, pH and bacteria level of the processing water need to be monitored and kept at optimum levels
- ☉ Recycling beneficial for coffee quality: when warm and enzyme loaded use water is recycled through wet parchment, fermentation is quicker!

4. Approaches to treatment (2)

--- Acidity ---

- ☉ Wastewater must be fully acidified and solids must be filtered out before water is further treated
- ☉ Acidification pond for 6 hours retention of waste waters to allow acidification and sedimentation of solids
- ☉ Before lead into waterways, the the acidified wastewater should be lifted from around pH 4 to at least pH 6 to 7
- ☉ Low cost, good availability and easy handling of natural limestone (CaCO_3) - other than the highly reactive burnt (CaH) or slaked limestone (Ca(OH)_2), natural limestone will not raise pH higher then 6.1 (automatic buffer point)



4. Approaches to treatment (4)

--- Biological Oxygen Demand ---

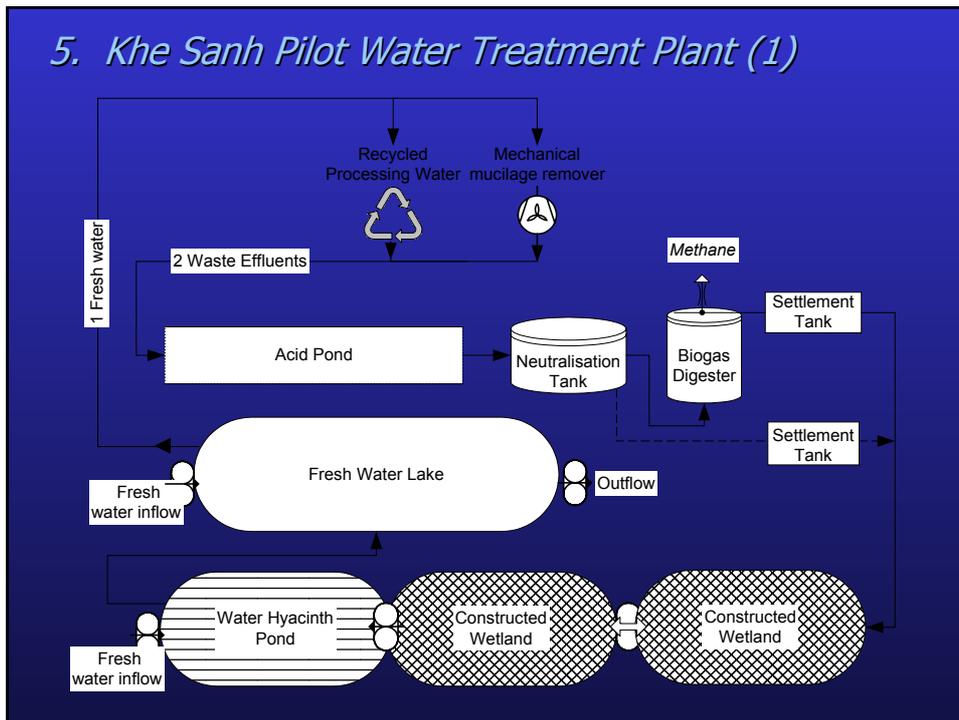
- 🍷 Before lead into waterways, BOD levels should be brought from 10.000 to 20.000 mg/litre down to 200 mg/litre
- 🍷 For larger scale processing of up to 100 tonnes cherry/day, simple anaerobic settlement ponds not feasible: too long retention times, smell nuisance, danger of overflow.
- 🍷 Recommended system:
 - Acidification, sedimentation and floating of solids
 - Neutralisation
 - Anaerobic digestion in Biogas Reactor (UASB)
 - Combined Aerobic/Anaerobic digestion in constructed wetland
 - Water polishing in water hyacinth pond

5. Khe Sanh Pilot Wastewater Treatment Plant

5. Khe Sanh Pilot Water Treatment Plant

Waste Water type	Required action	Installation	Remarks
Raw effluents from processing (recycled water, demuculator effluents, fermentation tank effluents)	Fermentation, Acidification and sedimentation of mucilage and pulp components diluted in the water	Long and shallow acidification tank	During acidification, a thick crust of raw mucilage will build up floating on the water. The middle layer is clear acid water, sediments will settle to the bottom. Regular cleaning is required.
Clear Acid water from acidification tank	Neutralisation with limestone (CaCO_3) to pH 6	Mixing tank with trash pump	Use powder or finely ground limestone.
Neutralised water (pH around 6)	Reduction of BOD and COD, consumption fertilising salts from reaction between acid and limestone (calcium acetate)	<ul style="list-style-type: none"> - Biogas digester - Wetland planted with reeds and rushes - Anaerobic settlement pond - Artificial aeration 	Depending amount of discharge water of the factory, the most suitable options is to be chosen.
Pre-treated waste water	Final cleanup of water	<ul style="list-style-type: none"> - Wetland planted with reeds and rushes - Water hyacinth pond - Final settle and infiltration area 	Acidity and BOD/COD are under control, however water might still be dark green to black in colour.

5. Khe Sanh Pilot Water Treatment Plant (1)



5. Khe Sanh Pilot Waste Water Plant (2)

--- Estimated Efficiency of Treatment System ---

	Acid Pond (In)	Neutralisation Pond	UASB Digster	Settling Tank.	Wet-land	Hyacinth Pond	Out-let
PH	3,8	6.1	6.1	6.5	6,5	7	7
BOD mg/l	20,000	10,000	1,000	800	<400	200	<200
Reduction in BOD	50%	Minor	90%	20%	50 %	50%	



Thank you for your attention!

