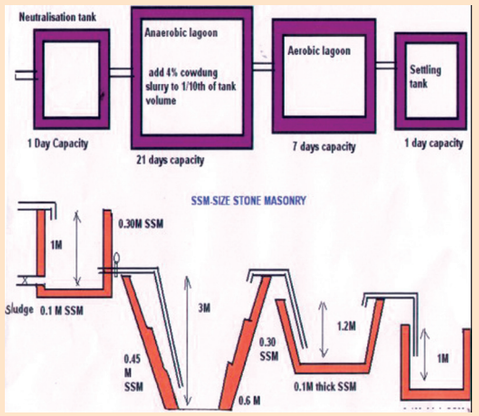
ppm, it should be diluted appropriately, so as to bring down the BOD level around 100 ppm.

- It is advisable to check the pH and BOD levels of the treated effluent by sending the treated effluent sample either to Central Coffee Research Institute (Chikkamagaluru, Karnataka) or any of the State Pollution Control Board's Laboratories.

General considerations to avoid effluent generation from coffee processing at on-farm level:

- Preparation of cherry coffee is one of the ways of avoiding water pollution.
- Preparations of pulped natural coffee also contribute towards avoiding the production of coffee effluent, to certain extent.
- Installation of ecopulper drastically reduces the effluent generation in the coffee estates.
- Central Coffee Research Institute renders advisory for the construction of effluent treatment plants (ETP) units for the treatment of coffee effluent and growers can contact for more information.



Schematic diagram of NEERI's ETP Model

Use of 8 mm screen to remove solid wastes (pulp) in the effluent (before feeding into the equalization/neutralization tank)

Addition of spray lime in liquid form into the equalization/ neutralization tank for effective neutralization

Norms/Standards for effluent from wet/parchment coffee processing (Source: Central Pollution Control Board's Website, Gazette Notification dated 24th January, 2020)

Sl. No.	Parameter	Standards
a.	pH	6.5 – 8.5
b.	BOD level (3 day, 27°C), mg/L	
	i) Storage in lined lagoons, (as specified by Central Pollution Control Board's Gazette Notification)	1,000
	ii) Discharge on land for irrigation	100

i) Raw, treated and/or diluted effluent shall not be discharged into surface water body or used for recharging ground water under any circumstances what so ever; ii) The non-permeable lining system shall be constructed by using well graded, highly impervious clay or geo-synthetic liners such as Geo-Synthetic Clay Liners (GCL), High-Density Polyethylene (HDPE) or a combination of both and shall achieve an in-situ coefficient of permeability of less than $1*10^{-7}$ cm/sec. The compacted clay liner must have a minimum thickness of 300 mm (or two compacted layers of 150 mm minimum thickness each). The finished lining must be tested to ensure that it meets the permeability criteria; iii) The effluent storage facilities/lagoon/solar evaporation ponds shall be located above high flood level mark of the nearby stream, rivulet etc. with below mentioned free board and away from any water body/stream at a distance. Free Board (cm) – 60; Distance (m) – 100; iv) The liner system specification and lagoon specification to be achieved in one year.

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MANAGEMENT OF COFFEE EFFLUENT AT ON-FARM LEVEL

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Pollution of natural water bodies by the effluent discharged from coffee processing units is an ecological problem in all the coffee producing countries, where coffee is processed by wet method. In India, currently about 80% of Arabica and 15% of Robusta coffees are processed by wet method. The processing of Robusta coffee by wet method is steadily surging due to the growing demand for Robusta parchment in the international markets. Coffee processing by dry method does not require water while wet processing needs water. During wet processing of coffee, water is used for conveying the fruits, separation of sound fruits from floats & dried berries, pulping of fruits, washing and post-wash soaking of wet parchment coffee. The primary waste products from various stages of wet processing are:

i) Liquid waste: The liquid waste/effluent from the pulper, washer and post-wash soaking mainly contains cellulose, pectin, poly phenols, proteins and sugars.

ii) Solid waste - Coffee pulp (fruit skin/sippae) contains cellulose, fiber, pectin, protein and tannin.

Characteristics and quantum of coffee effluent generated during wet processing of coffee:

The pollution load of an effluent is measured by physical and biochemical parameters like colour, odour, pH, Biological Oxygen Demand (BOD) level, Chemical Oxygen Demand (COD) level, total dissolved solids (TDS) content and total suspended solids (TSS) content. In general, the fresh coffee effluent is light brown in colour with little odour. The pollution parameters such as pH ranges from 4.5 to 5; BOD level - 2.5 to 12 gram per litre (i.e. 2,500 to 12,000 ppm); COD level - 7.2 to 23 gram per litre (i.e. 7,200 to 23,000 ppm); TDS content – 6 to 10 gram and TSS content - 4 to 7 gram per litre.

The effluent generated from coffee processing unit is rich in both suspended and dissolved solids, which are biodegradable. The coffee effluent, if discharged into natural water bodies without treatment, pollutes the receiving water bodies by depleting dissolved oxygen present in it. Pollution of natural water bodies will have an adverse effect on domestic users, aquatic life, livestock and coffee processing units in the downstream. The problem of water pollution will be intensified in coffee tracts, as the processing period coincides with the dry season during which the flow in natural water bodies will be at minimum level. The solid waste (i.e. pulp/fruit skin/sippae) is not posing much problem, as most of it is returned to plantations after composting or vermi-composting.

The studies conducted from time to time on the quantum of effluent generated revealed that around 22,000 to 60,000 liter and 28,000 to 70,000 liter of effluent is generated for every tonne of clean coffee bean of Arabica and Robusta produced, respectively (in case of Arabica, 5,550 kg to 6,000 kg of ripe fruits produces one tonne of clean coffee while in Robusta 4,500 kg 5,000 kg of ripe fruits produces one tonne of clean coffee).

However, after the introduction of "water recycling mechanism" in the pulper unit by the Research Department of the Coffee Board, the quantum of effluent generated is sizably reduced to 16,500 to 22,000 and 25,000 to 30,000 liter of effluent for every tonne of clean coffee of Arabica and Robusta produced, correspondingly.

Further to the above, following the introduction of "Ecopulper" (a new generation pulper-cum-washer machine), the quantum of effluent generated is further reduced to 4,500 to 6,000 and 6,500 to 7,500 liter of effluent for every tonne of clean coffees of Arabica and Robusta, produced respectively. The thick effluent released from the washer unit of the ecopulper is mechanically mixed with the pulp (released from the pulper) during the course of coffee processing itself and then discharged to compost pit using screw conveyer. Thus, the effluent generation is almost nil in case of Ecopulper. The pulp and effluent together composted for about four to five months in the compost pit. Once, the compost is matured, it is applied back to the plantation, as and when required.

The Research Department of Coffee Board advocates installation of Ecopulper for two important reasons: i) effluent generation is almost nil and ii) there is no need for the construction of a full-fledged effluent treatment plant (ETP) units as prescribed by Karnataka State Pollution Control Board, for the treatment of coffee effluent. The CPCB has prescribed norms for coffee processing industry [The Environment (Protection) Rules, 1986] is detailed in the table below.

Management of Coffee Effluent

Coffee effluent contains more than the stipulated levels of BOD & COD and thus it has to be treated following the recommended methods of treatment, before use in the field or discharging it to the natural water streams.

The Research Department of the Coffee Board in technical collaboration with the National Environmental Engineering Institute (NEERI), Nagpur had developed a treatment method/scheme during 1980 for treating the effluent generated from wet processing of coffee. This treatment method is basically an anaerobic-cum-aerobic digestion method. The basic unit of NEERI ETP model consists of i) one equalization tank, ii) two anaerobic lagoons, iii) one aerobic lagoon and iv) one settling tank. The NEERI-ETP do not require lining of lagoons, as they are made up of size stone masonry construction and thus ensure water tightness and effluent does not percolate into ground water.

The steps to be followed for the treatment of coffee effluent following NEERI-ETP unit is detailed here-under:

- All the solid materials such as fruit skin, broken wet parchment and parchment cover should be separated from the pulped water and fresh effluent coming out of washer, using suitable screens (screen with 4 mm diameter holes), so as to reduce the pollution load.
- The coffee effluent coming out of the washer should be stored in a tank/lagoon (called as equalization tank/lagoon) for about one day. The capacity of this lagoon should be of one day's water use capacity of the processing unit during peak harvesting period.
- The effluent in the equalization tank/lagoon should be neutralized with appropriate amount of liming material (eg., spray lime) to raise the pH of the fresh effluent to neutral range (around 7 pH). Generally, five kg of good liming material is adequate enough to neutralize one thousand litre of effluent. Further, the liming material (which is usually in the powder form) should thoroughly be dissolved either in water or fresh effluent itself. After complete dissolution of liming material, add only the liming solution to the equalization tank/lagoon. This process of adding the liming solution into the equalization tank/lagoon ensures neutralization very effective, as compared to adding the liming material in the powder form.
- After one day of storage in the equalization lagoon, the effluent is allowed to the anaerobic lagoon. Before allowing the effluent to the anaerobic lagoon, the anaerobic lagoon should be charged with 4% cow dung slurry up to 10% of the capacity of the lagoon. Charging of the anaerobic lagoon should be done one month before the pulping operation starts so that the methanogenic bacteria present in the cow dung slurry which are responsible for the degradation of the biological materials get stabilized. The capacity of the anaerobic lagoon should be equivalent to 21 days effluent production with a maximum depth of 3 meters. Add 5 kg of urea and 2.5 kg of single super phosphate (SSP) per every 20,000 liter of effluent to accelerate the degradation process.
- After 21 days, the effluent from anaerobic tank should be allowed to the aerobic tank. The depth of aerobic lagoon should not be more than one meter and capacity should be of 7 days effluent production. In aerobic lagoon, addition of 500 gram of urea and 250 gram of single super phosphate (SSP) per 20,000 liter of effluent is essential.
- The effluent coming out of the aerobic lagoon be then stabilized in another tank (settling tank) for one day and used for irrigation, if the BOD level is around 100 ppm. If the BOD level is more than 100

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