

Reduction of Carbon Foot Print in Long Distance Milk Transportation



by Concentration techniques like RO and Evaporation



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What is Carbon Foot Print?

- ✓ Quantity of Green House Gases (GHG) emission caused by an organization/ event/ product, expressed in (Kg/Tons) of carbon dioxide or its equivalent of other GHGs

What is the GHG Emission contribution of Dairy Industry?

Sr. No	Contribution of global GHG emissions by	Percentage
1	Milk production, processing and transportation	2.7
2	Meat production from dairy animals.	1.3
	Total	4

* Ref: FAO report dtd 20th April 2010

India's Milk Production Scenario

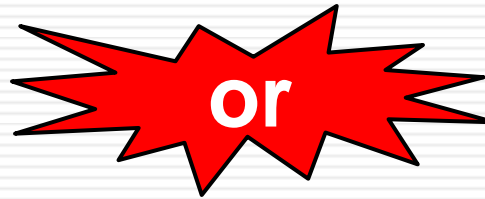
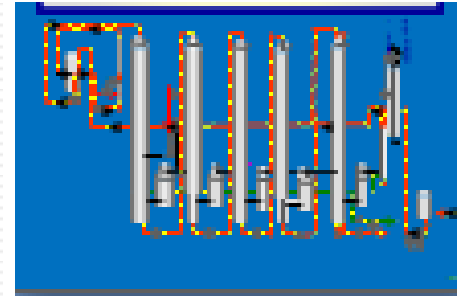
- ✓ Largest milk producer in the world
- ✓ Estimated milk production - 108.5 MT per annum, 2008-09
- ✓ Accounting to 16 % of global milk production.

Need for Pasteurized Chilled Milk Transportation in India

- ✓ States with surplus and deficit of milk
- ✓ Faster urbanization
- ✓ Increased health awareness

Concentration Techniques

- ✓ **Evaporation**
 - ✓ Milk can be concentrated in multi-effect TVR/ MVR based falling film evaporators



- ✓ **Membrane Concentration – Reverse Osmosis**
 - ✓ RO is a pressure driven membrane separation technique
 - ✓ Membranes are used to separate different components in a fluid based on their molecular sizes.
 - ✓ RO membranes have pore sizes less than 0.001 micron and operating pressure range of 400-1000 psi

What is the advantage of Reverse Osmosis ?

- ✓ No phase change unlike evaporation technique which preserves the functional properties of proteins
- ✓ Product does not have any cooked flavor since whole milk is typically concentrated < 6°C
- ✓ At this temperature fat molecules are not ruptured and hence no rancidity flavor in the concentrated milk.

Concentration level for Transportation of Milk

- ✓ Even though theoretically whole milk can be concentrated to 48 % in an evaporation plant while producing milk powder, the limit here for transportation at 2° C is around 30 %
- ✓ This is due to higher viscosity of chilled concentrate and also to avoid fat separation during transportation

Comparison of Process steps involved in all form of Transportation

Process	Un-concentrated Milk	Concentrated milk by	
		Evaporation	Reverse Osmosis
Pre-transportation	Pasteurization and chilling - 4 Deg C	Pasteurization and chilling - 4 Deg C	Pasteurization and chilling - 4 Deg C
	-	Concentration by evaporation (28% and 4 Deg C)	Concentration by Reverse Osmosis (28% and 4 Deg C)
	Deep Chilling - 2 Deg C	Deep chilling of concentrate - 2 Deg C	Deep chilling of concentrate - 2 Deg C
Transportation	Transportation	Transportation	Transportation
Post-Transportation	-	Dilution with DM/R.O water	Dilution with DM/R.O water
	Re-pasteurization, Standardization and packing	Re-pasteurization, Standardization and packing	Re-pasteurization, Standardization and packing

Case Study – Assumptions

1. Pasteurized Milk Transported Per Day : 2,00,000 LPD

Sr No	Type of Milk	Qty (in %)
1	Toned Milk (11.5 -12 % TS)	20
2	Whole Milk (15.4 % TS)	80

2. Concentrated milk transported per Day : 96,500 LPD of 28 % TS
3. Milk is concentrated either through a 5 – effect TVR based evaporation plant or in R.O plant at feed rate of 10,000 LPH.
4. Transportation distance for one way is 1000 km.

Case Study - Assumptions

5. Common activities excluded from CO₂ emission :

- ✓ Machine Milking & Chilling
- ✓ Raw Milk Transportation
- ✓ Raw Milk Chilling
- ✓ Milk Pasteurization
- ✓ Standardization
- ✓ Re-pasteurization & Re-standardization
- ✓ Packed Milk Storage & Transportation

6. CO₂ Emission values :

Sr. No.	Utilities Name	Co2 emission	Remarks
1	Power generation using 50 % coal and 50 % natural gas	777 gm - CO ₂ Eq/ KW-hr	CO ₂ emission of coal and gas based plants are 955 and 599 gm - CO ₂ Eq/ KW-hr respectively.
2	Steam generation through Furnace oil	205 gm - CO ₂ Eq/Kg	Steam produced is 13 Kg/ Kg of FO
3	Cooling load per Ton of Refrigeration	1166 gm - CO ₂ Eq/ TR	Power consumed is 1.5 KW/TR
4	Tanker using diesel as fuel	658 gm CO ₂ Eq/ Litre	Average fuel consumption is 4 km/Litre

Outcome of Case Study

Sr. No	Process	Elements	Emission (CO ₂ -gm- Eq / Unit)	Pasteurised Milk (Without Concentration)		Concentrated milk through			
				R.O		Evaporation			
				Consn. Fig.	CO ₂ -Emission (Kg)	Consn. Fig.	CO ₂ -Emission (Kg)	Cons n. Fig.	CO ₂ -Emission (Kg)
1	Pre-Transportation	Power - KW-Hr	777	-	-	1517	1179	570	443
		Steam- Kg	205	-	-	336	69	1900 0	3902
		Chilled Water - TR	1166	-	-	291	339	-	-
2	Transportation	Diesel - Litres	2664	5000	13320	2406	6411	2406	6411
3	Post Transportation	Chilled Water - TR	1166	-	-	892	1039	892	1039
		Power - KW-Hr, R.O Water	777	-	-	187	145	187	145

Total CO₂- Emission

13320

9161

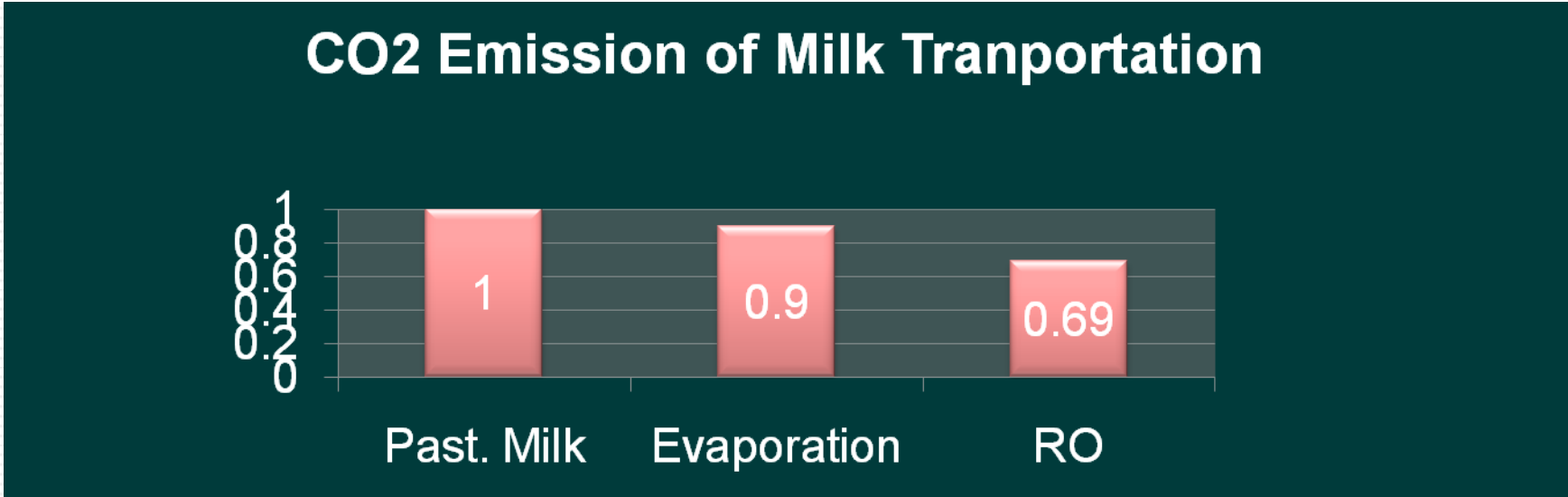
11,940



Whole Milk concentration plant in Mexico by GEA Filtration

- Year of Installation – 2008
- Capacity – 30 KLPH
- Initial concentration – 12% (4% fat)
- Final concentration – 28 %
- Distance transported – 900 km

Conclusions



Message
to
Dairy Industry

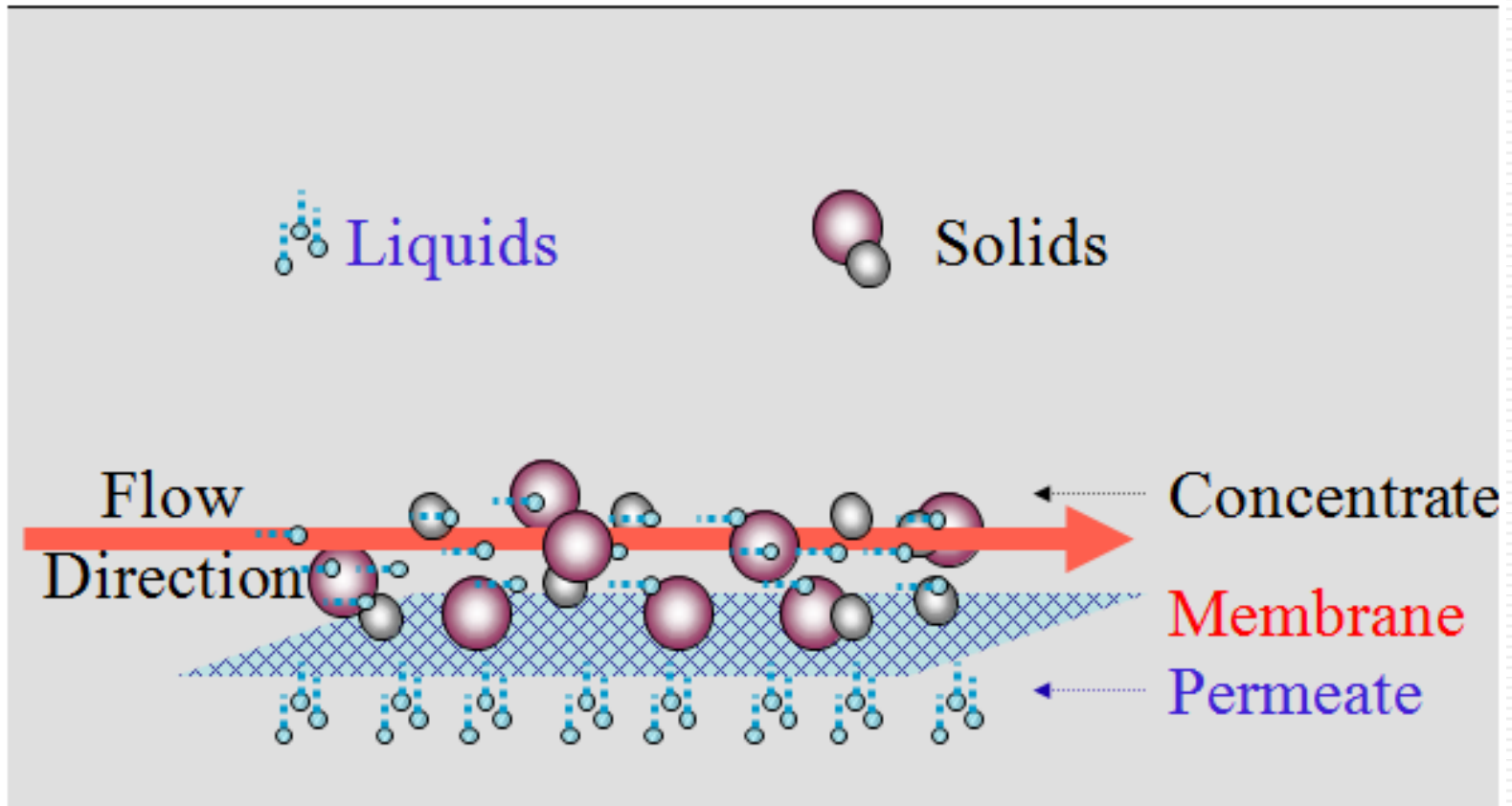


By
Concentration
Through
Reverse Osmosis

Message to
Dairy Institutions – Bring awareness of Reverse Osmosis and
encourage research and studies in this field.

THANK YOU

Membrane Filtration Basics



Reverse Osmosis – Typical Separation Diagram in milk Conc.

Reverse Osmosis
High Pressure (400 PSI - 1000 PSI)

