

EXPERIMENTAL STUDY ON FLOW CHARACTERISTICS FOR THE HIGH EFFICIENCY TRANSPORTING OF THE DREDGED SOIL

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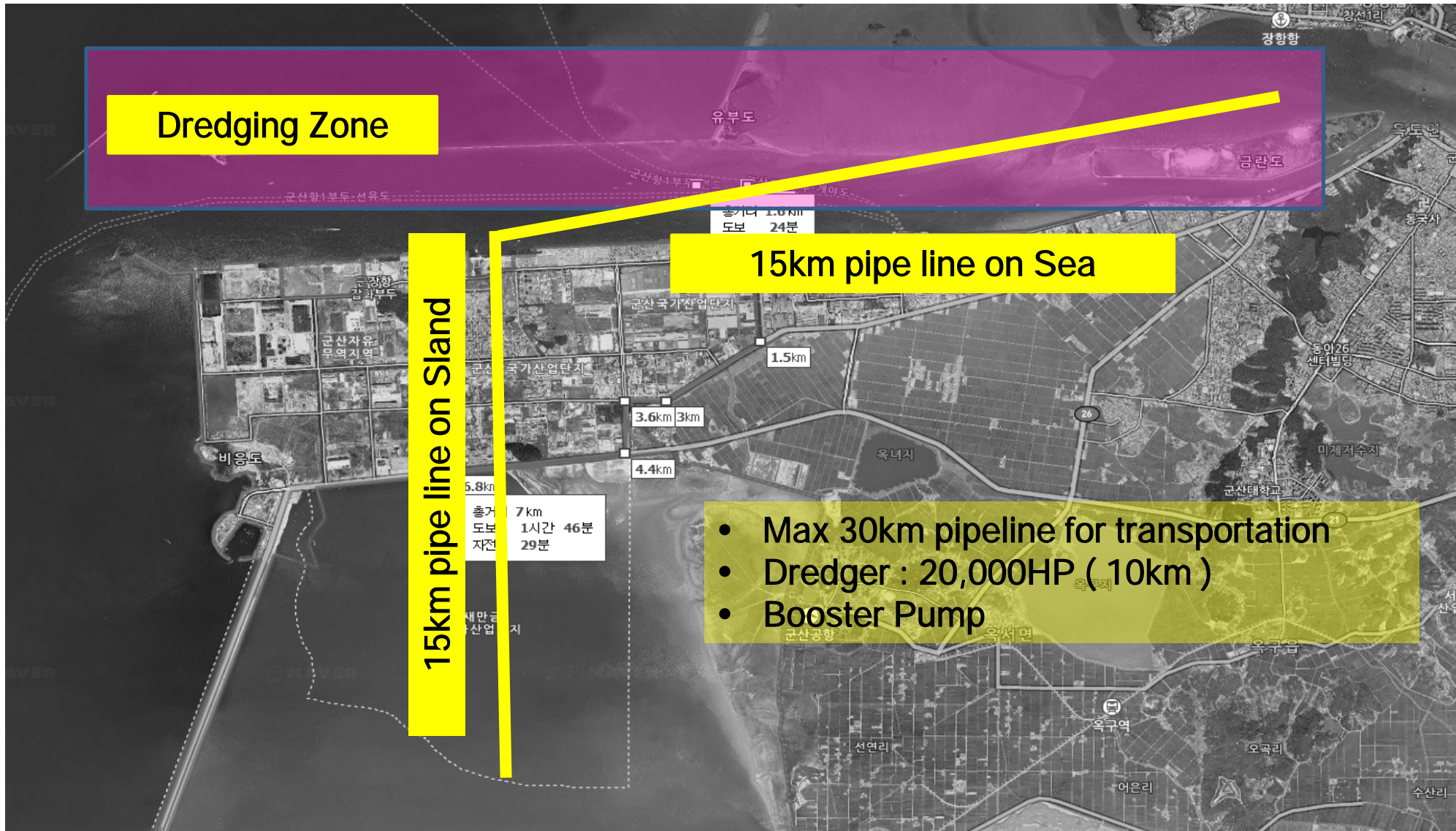
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1. INTRODUCTION

RESEARCH PURPOSE





DEFINE PUMPING EFFICIENCY

▪ PUMPING EFFICIENCY ↑

▪ HYDRAULIC GRADIENT ↓

▪ POWER CONSUMPTION ↓

▪ FLOW RATE ↑

- Transportation Length

$$L = \frac{2g \times H \times D}{\lambda \times V^2}$$

- Hydraulic Gradient

$$H = \left(\lambda \times \frac{V^2}{2g} \times \frac{L}{D} \right) + 10$$

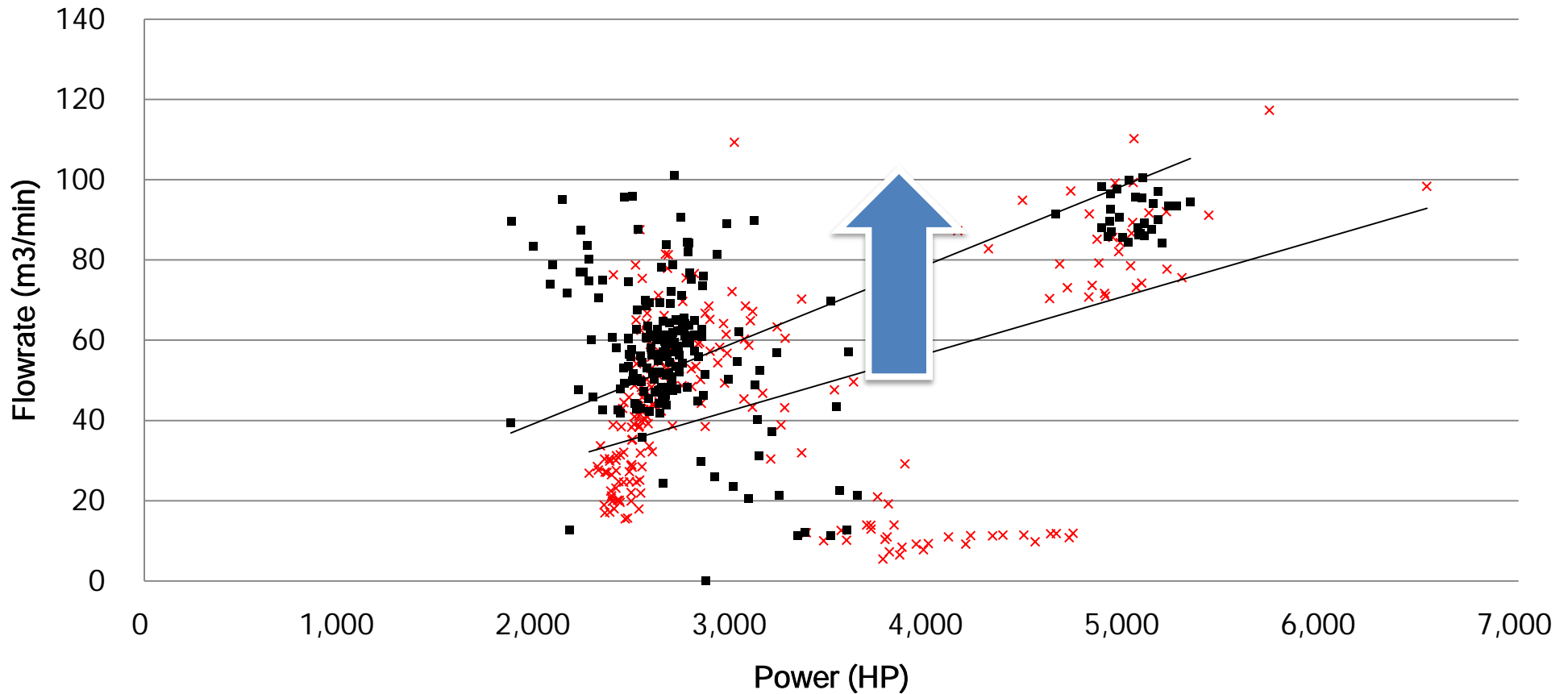
- Pump Power

$$N = \frac{\gamma \times Q \times H}{75 \times \eta \times 3,600}$$



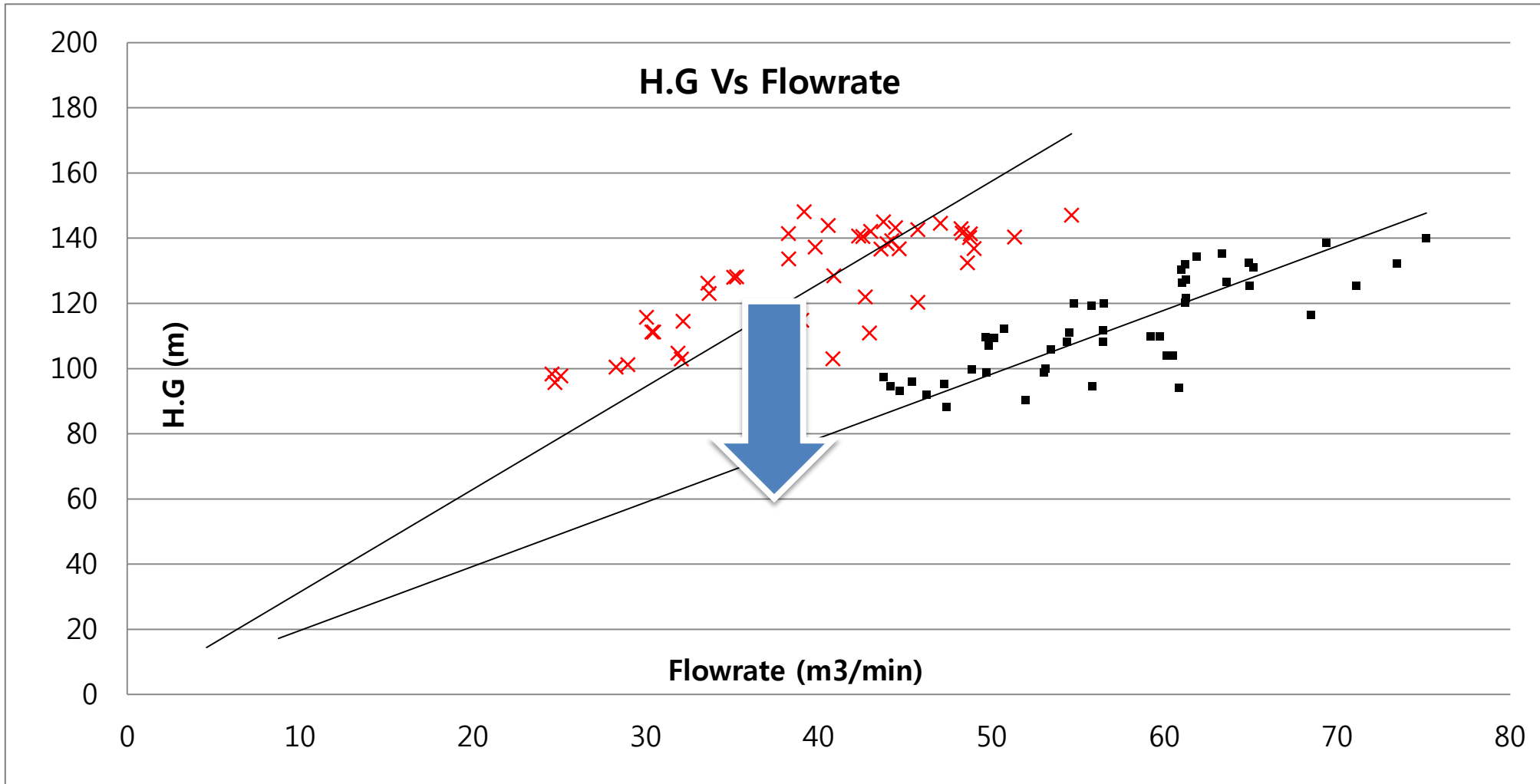
DEFINE PUMPING EFFICIENCY

Total Power Vs Flowrate





DEFINE PUMPING EFFICIENCY





SOLUTION

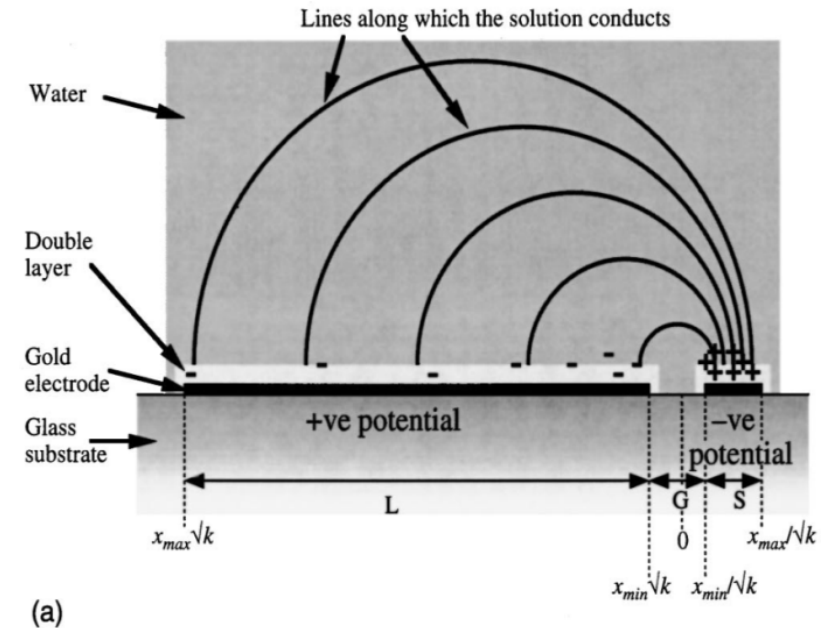
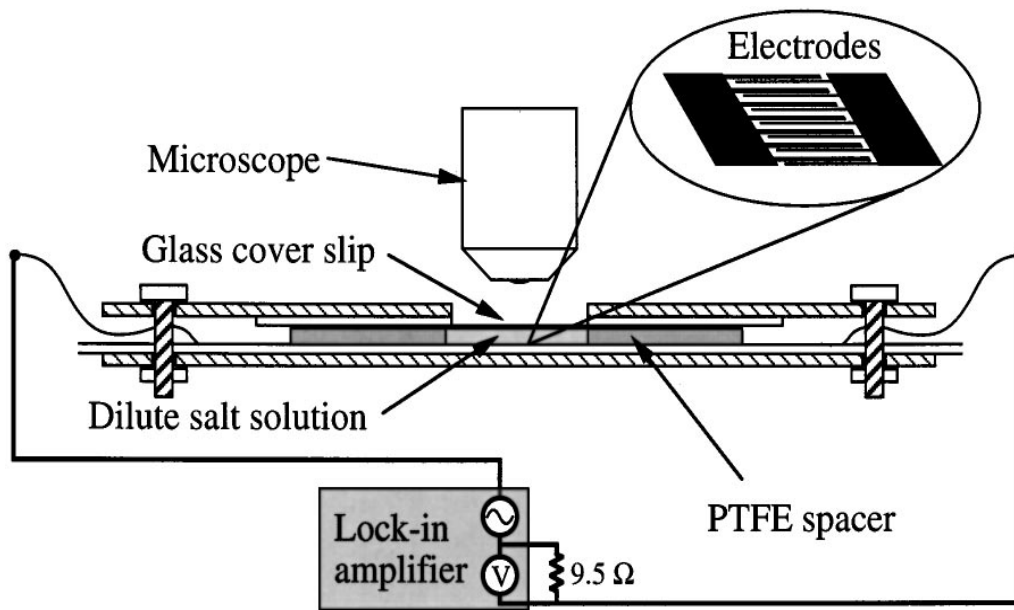
Pumping of water with ac electric fields applied to asymmetric pairs of microelectrodes

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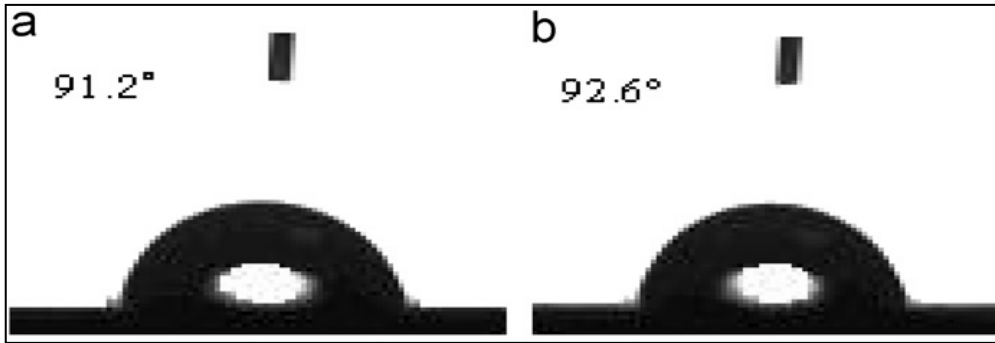
(Received 31 July 2000; published 20 December 2000)



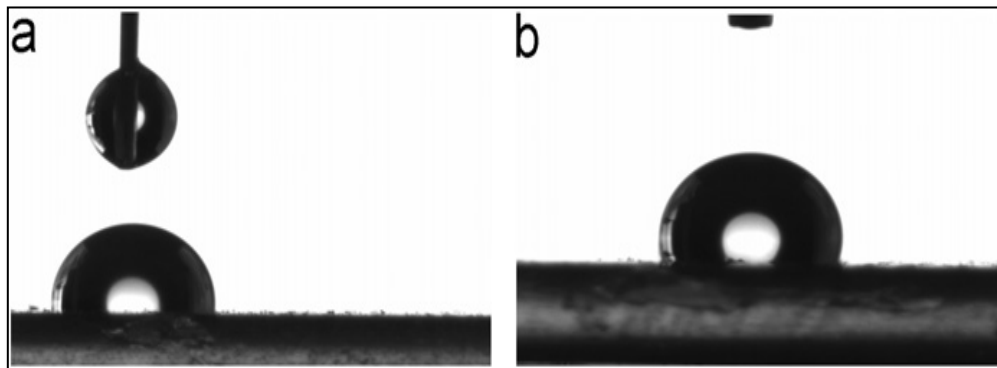
A cross section of the cell used. The PTFE spacer provided a gap of 340 μm above the electrodes which was completely filled with solution. The electrodes were driven with a lock-in amplifier that allowed the impedance of the cell to be measured.



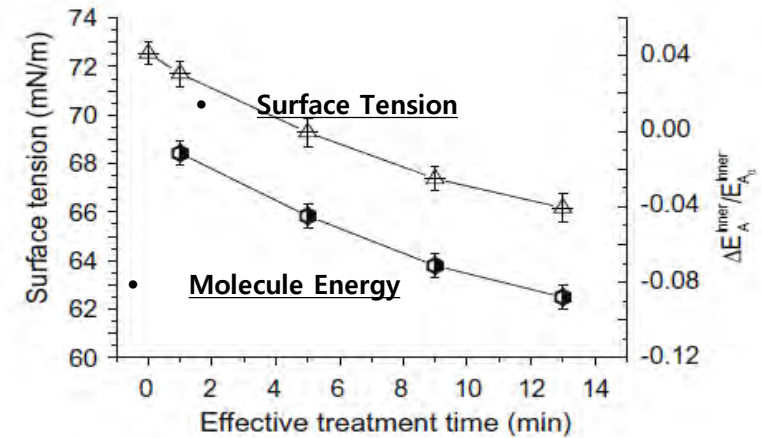
SOLUTION



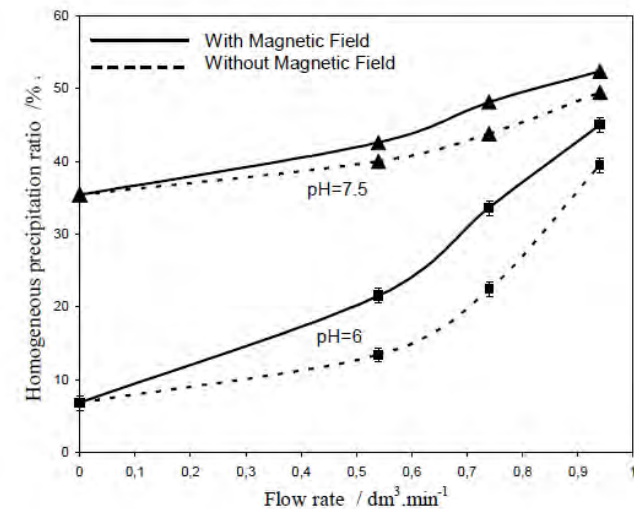
The angles of contact of magnetized water (a) and pure water (b) on the surface of graphite.



The angle of contact of magnetized water(a) and pure water (b) on the surface of silica gel of PDMS183.



- Magnetized solution Solubility Comparison
- Surface Tension release by Electro-Magnetic field



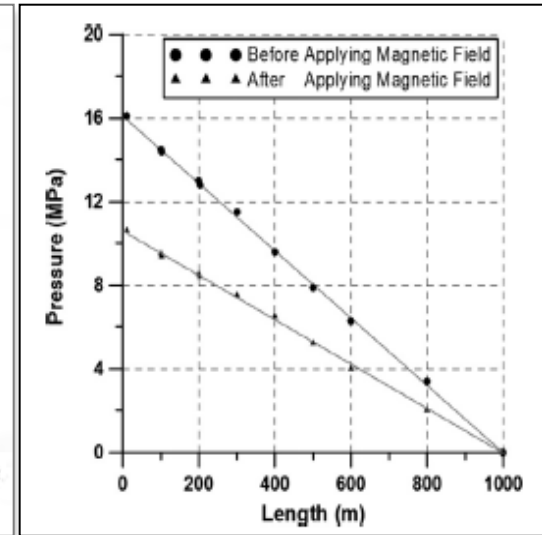
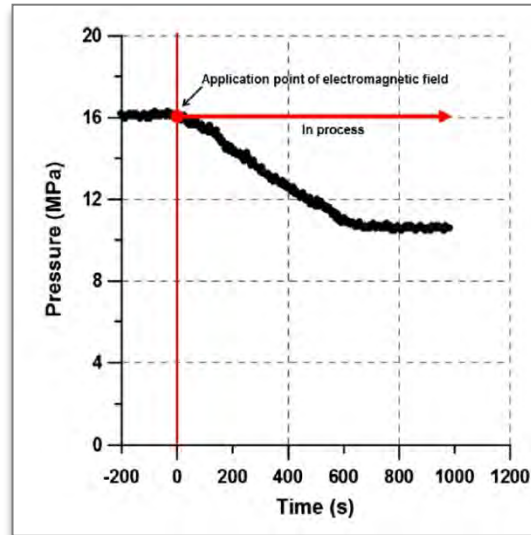
PRINCIPLE



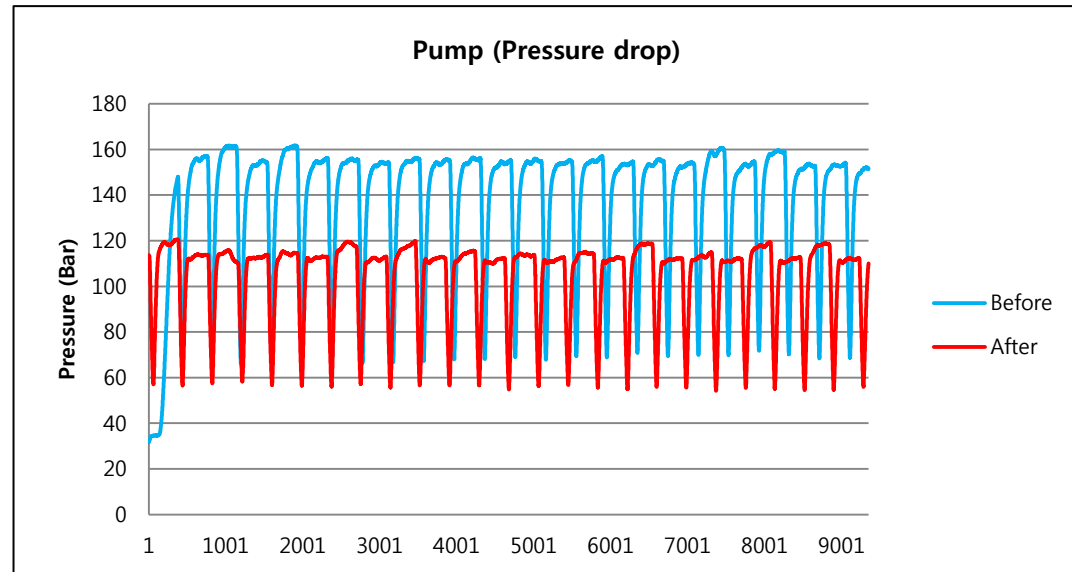
SOLUTION







- Mok po Test Site



- Fluid-Liner (EMF) Installation



RESEARCH HISTORY

STEP	LENGTH	PUMP	CONTENTS	SITE PHOTO
LAB TEST	30m/ 300m Transpo rtation	Robe Centrifugal	<ul style="list-style-type: none"> Effect of EMF Velocity profile Pumping test using each type Soil 	
SITE TEST	500m/ 1,000m Transpo rtation	Centrifugal (1,500 HP)	<ul style="list-style-type: none"> Reflect ion of Real site condition Effect of EMF on Real Site 	
LAB TEST	300m Transpo rtation / Pouring	Robe Piston (1,000HP)	<ul style="list-style-type: none"> EMF Applying test under various pumping conditions 	
SITE TEST	12km Transpo rtation	Centrifugal (20,000HP)	<ul style="list-style-type: none"> EMF Applying test on the Real Site over 10 km 	

2. TEST CONDITION

TEST SITE



Dredger

20,000 HP DREDGER



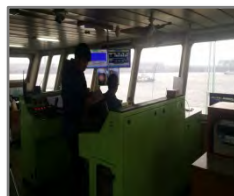
- PIPE LINE LENGTH : 9.5 km
- Dredging Depth : -13 m
- 4500 HP Pump * 1 ea, 6125 HP Pump * 2ea



- EMF Inductor Installation



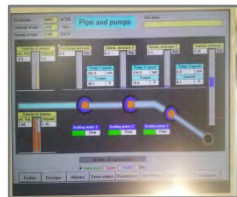
- EMF Device Setting



- Operation Condition



- Ground Condition



- Pump Operation



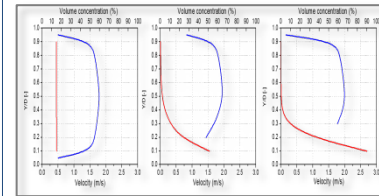
- Operation power

Station

Measurement Station



- Measurement Device Installation
- Expert System : Velocity Profile Vs Concentration Profile
- Mesh Network Data transporting



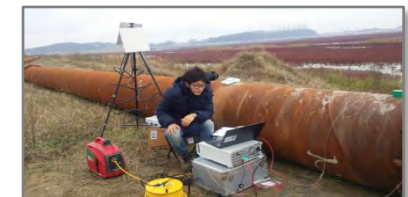
- Velocity Vs Concentration



- Density Flow



- Surface Tension



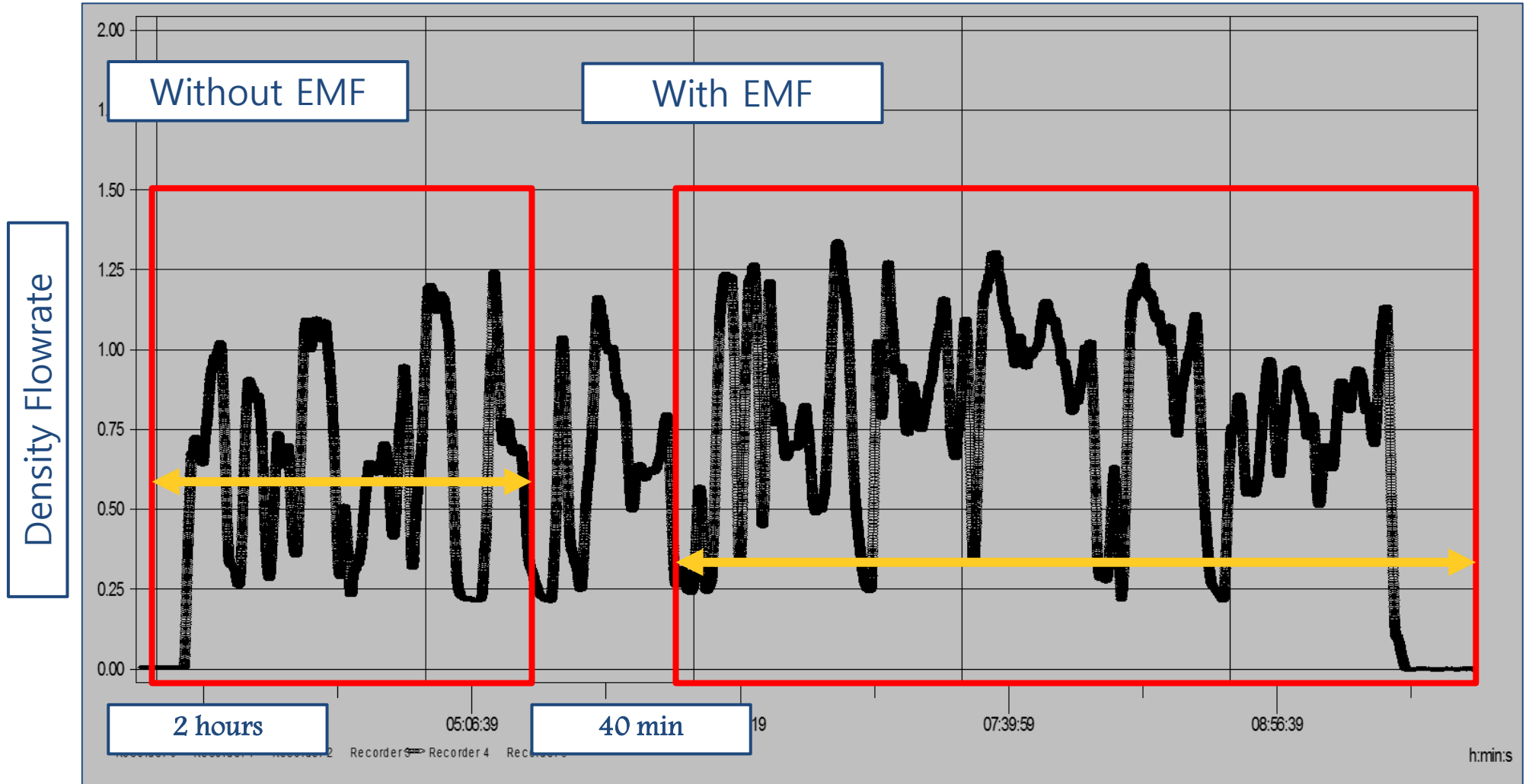
- UVP
- Velocity Profile

3. TEST DATA

DATA FORMAT



1 DAY DATA TREND



h:min:s



PUMP POWER DATA

Time	Pressure (bar)				Pump #1 RPM			Pump #2 RPM			Pump #3 RPM		
	suction	interm 1-2	interm 2-3	Dis charge	MHCP	Motor #1	Pump #1	MHCP	Motor #2	Pump #2	MHCP	Motor #3	Pump #3
13:10:36	0.59	3.6	8.1	12.6	4.5	590	214	3.7	580	238	2.4	580	230
13:11:36	0.52	3.6	8.4	13.2	4.5	590	213	3.7	580	238	2.4	580	230
13:13:36	0.6	3.6	8.2	12.8	4.5	590	216	3.7	580	238	2.4	580	230
13:09:36	0.64	3.5	7.9	12.4	4.5	590	214	3.7	580	238	2.4	580	230
13:14:36	0.61	3.6	8.2	12.8	4.5	590	214	3.7	580	238	2.4	580	230



DREDGER OPERATION

Cutter			Toque			Total MHCP
Depth	Load	RPM	Pump #1	Pump #2	Pump #3	
10.5	736	7.5	38.9	47.7	43.6	10.6
10.4	773	6.9	43.1	49.8	46.3	10.6
10.5	795	7.4	39.4	49.2	44.3	10.6
10.4	780	7.1	38.1	46.4	42.2	10.6
10.6	613	7	39.1	48	44.2	10.6



FLOW SPECIFICATION

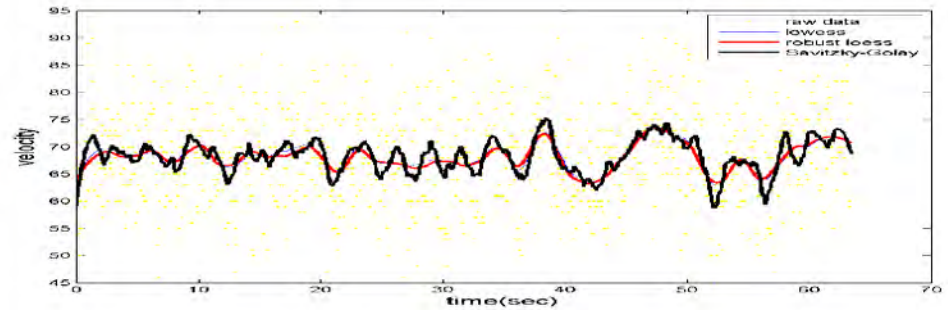
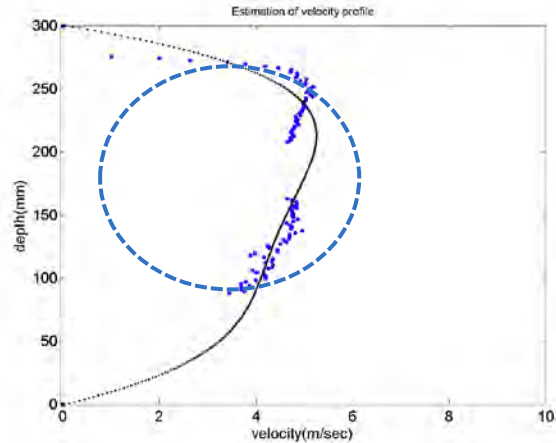
MHCP POWER	PUMP POWER	POWER DIV	MHCP EST. POWER	H.G	B.Density [g/cm ³]	B.Vel [m*Hz]	U.Density [g/cm ³]	U.Vel [m*Hz]	Bottom D.Flowrate [m ³ /min]	Upper D.Flowrate [m ³ /min]	Mean Density [g/cm ³]	Mean Velocity [m/s]	Mean D.Flowrate [m ³ /min]
5887.8	2508.2	0.9	236.6	40.6	1.2	2.7	1.1	3.0	55.4	52.8	1.1	2.9	54.1
5887.8	2680.5	1.0	252.9	43.3	1.2	2.6	1.1	2.9	53.9	53.8	1.1	2.7	53.8
5887.8	2562.6	1.0	241.8	56.8	1.1	2.8	1.1	3.1	43.3	38.3	1.1	3.0	40.8
5887.8	2442	0.9	230.4	70.4	1.1	2.9	1.1	3.1	35.2	29.0	1.1	3.0	32.1
5887.8	2527.9	0.9	238.5	73.4	1.1	2.8	1.1	3.2	34.2	29.6	1.1	3.0	31.9

4. DATA ANALYSIS

VELOCITY PROFILE

Measuring by UVP

After EMF



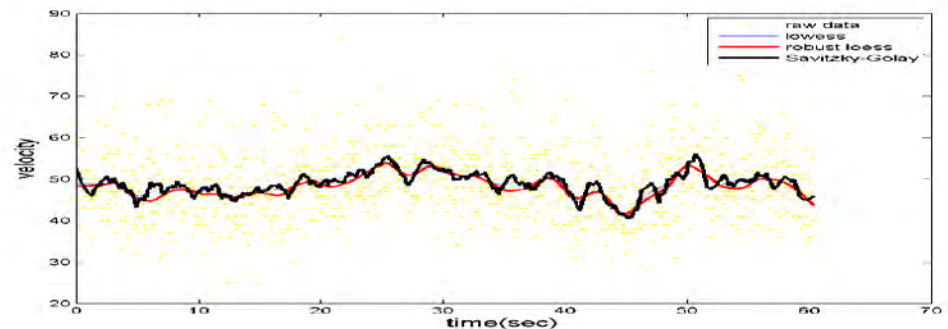
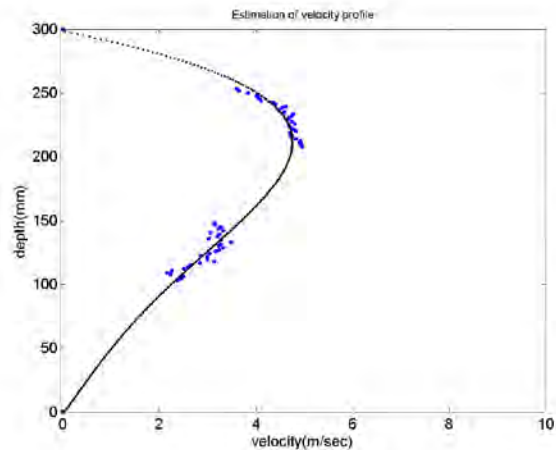
Slip Layer

• Clean Flow around the surface of pipe. (50% increase)

Max Velocity

• Center Vel. 6% increase, Mean Vel. 20% increase

Before EMF



Surface

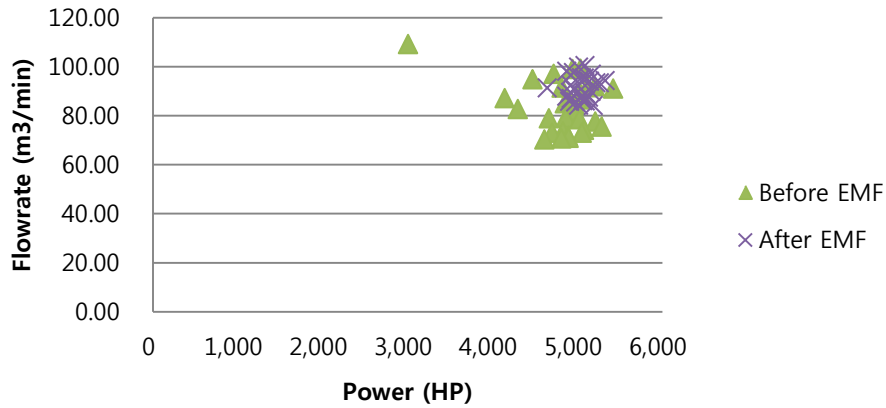
• When Non-FL, Moving Bed

Time history

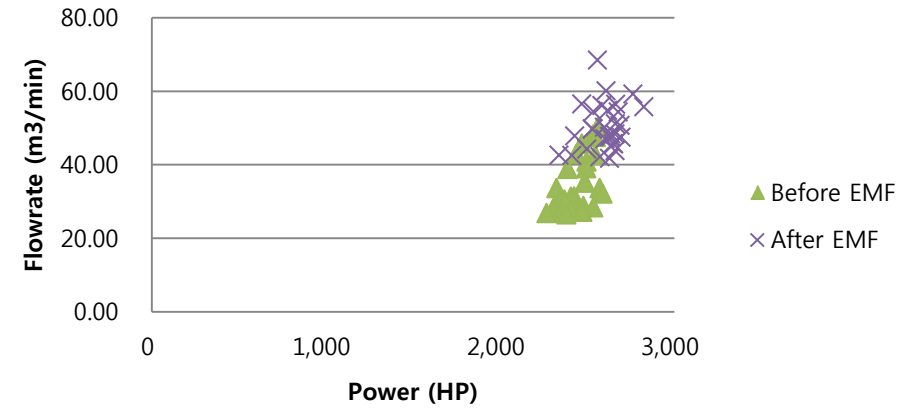
• There are no fluctuation : No FL clean flow effect.

POWER VS FLOWRATE

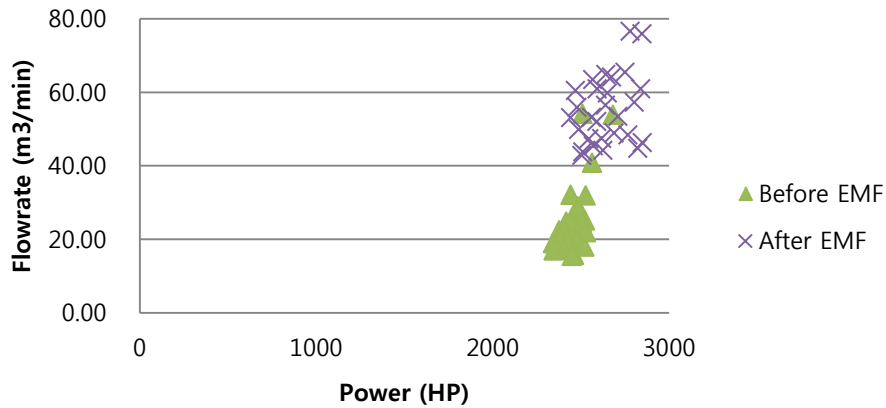
Case I [Gravel]



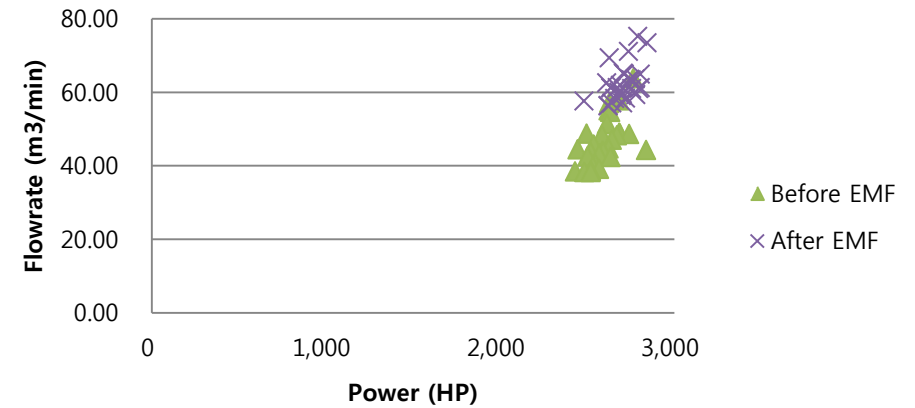
Case III [Sand + Silt]



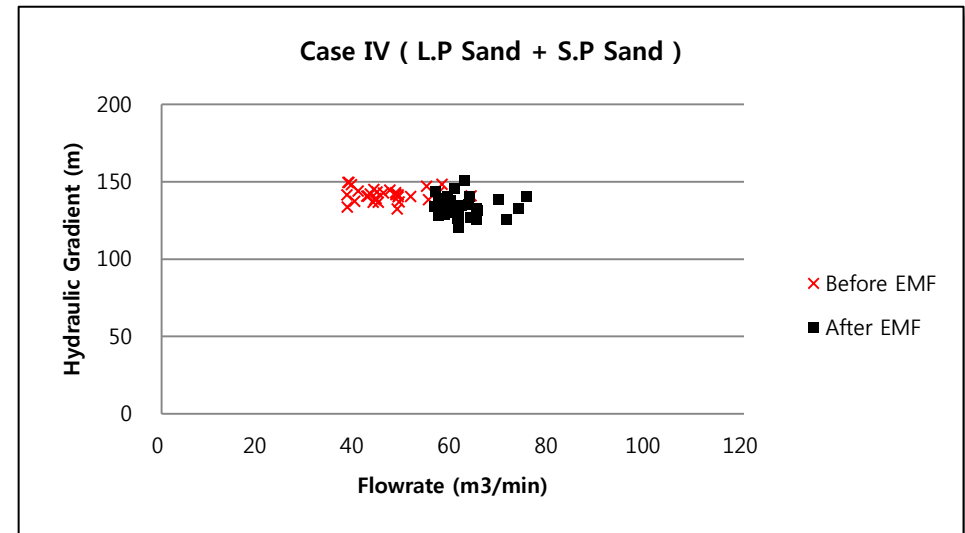
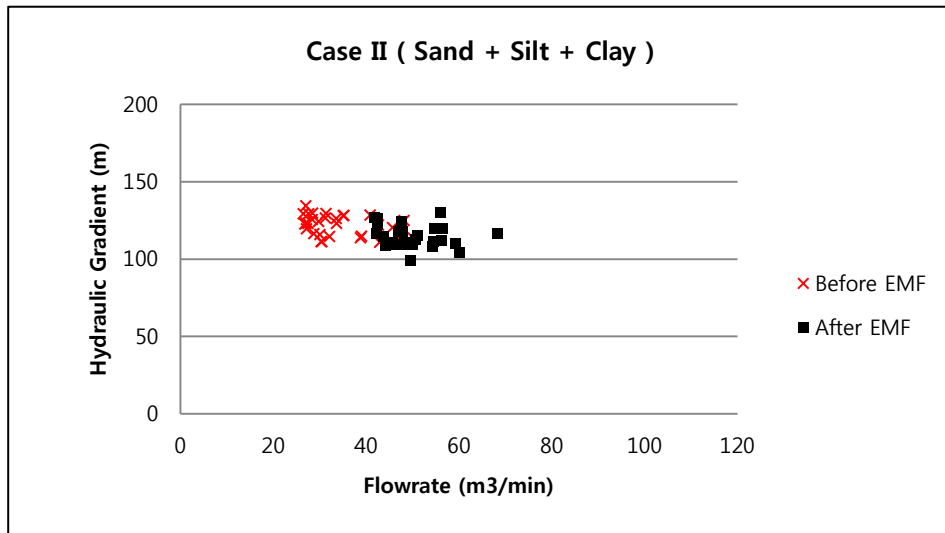
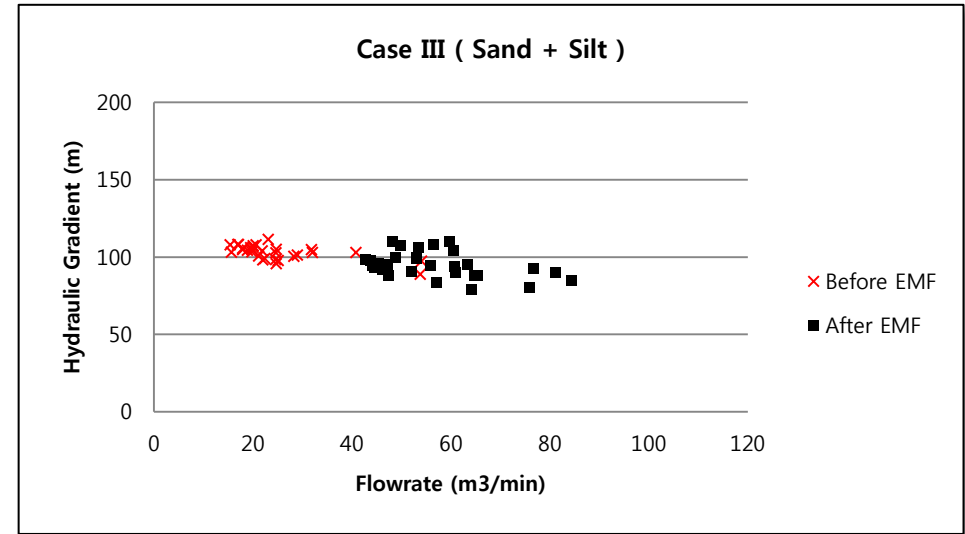
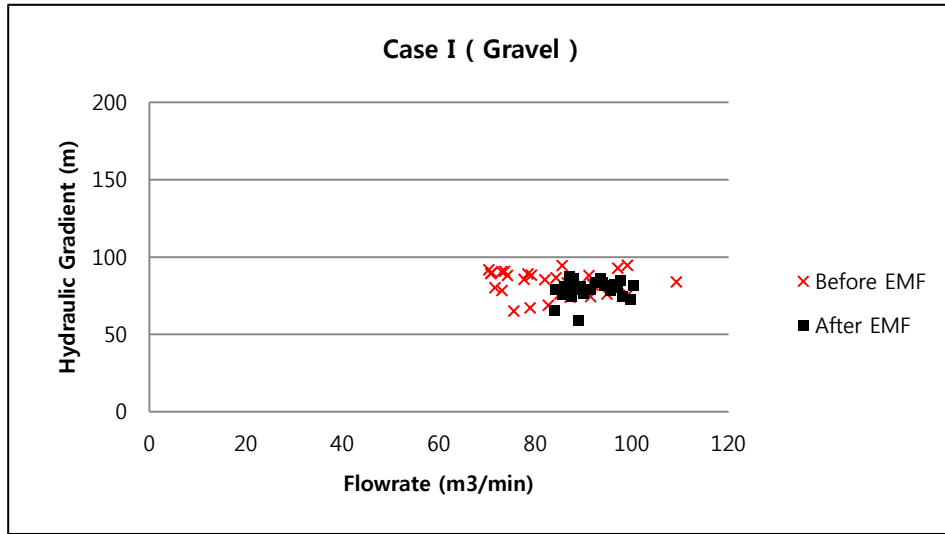
Case II [Sand + Silt + Clay]



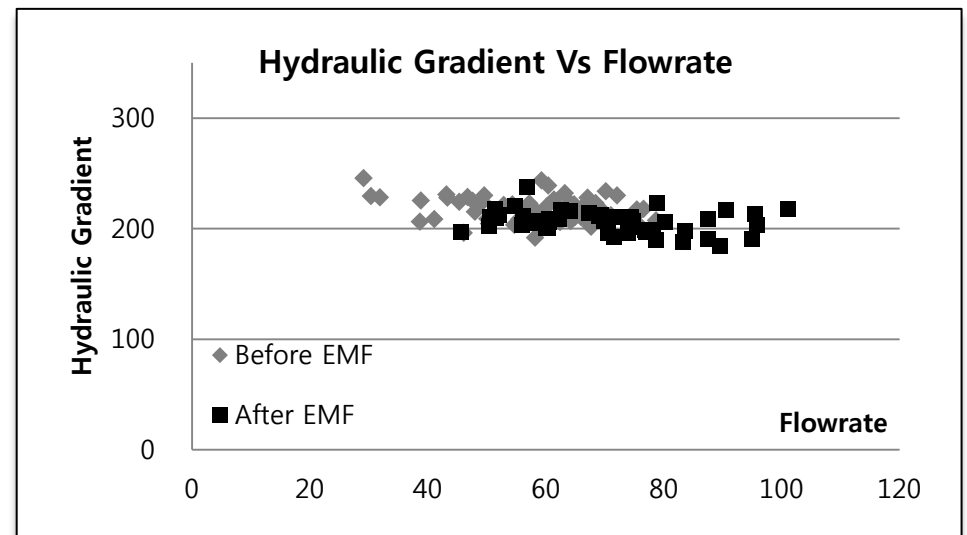
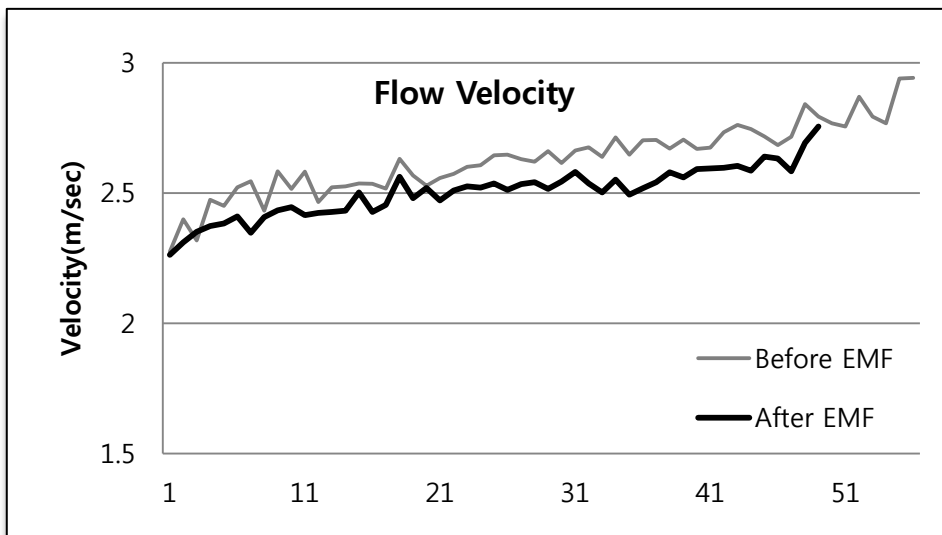
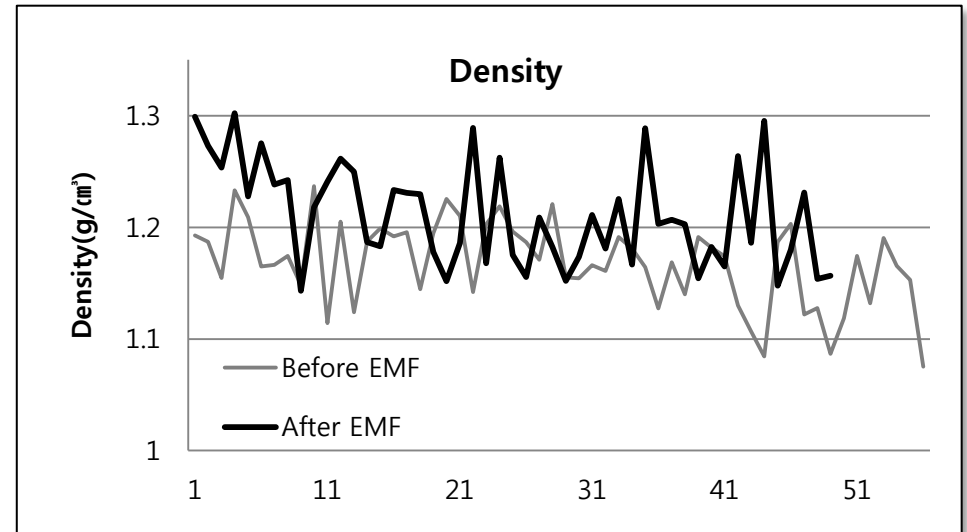
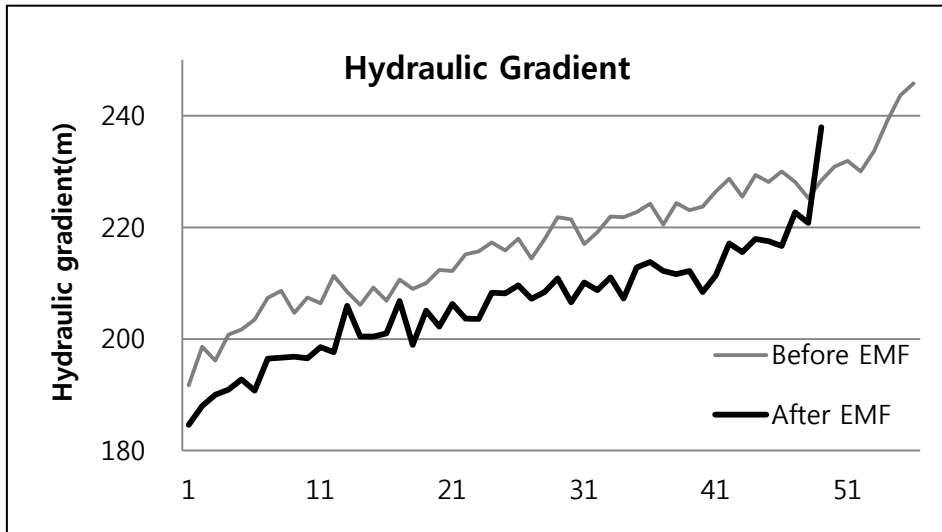
Case IV [L.P Sand + S.P Sand]



HYDRAULIC GRADIENT Vs FLOWRATE

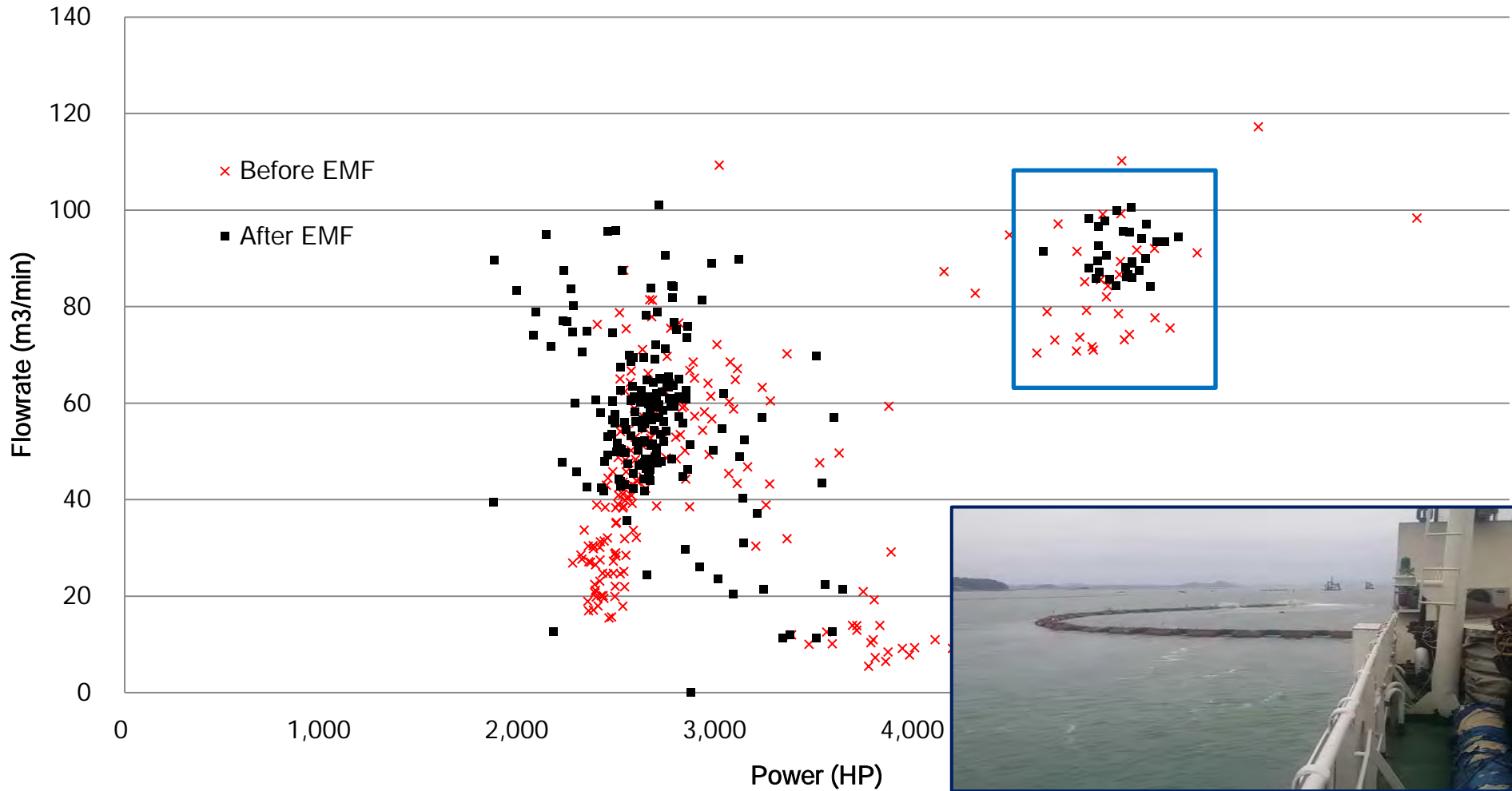


PARAMETER COMPARISON



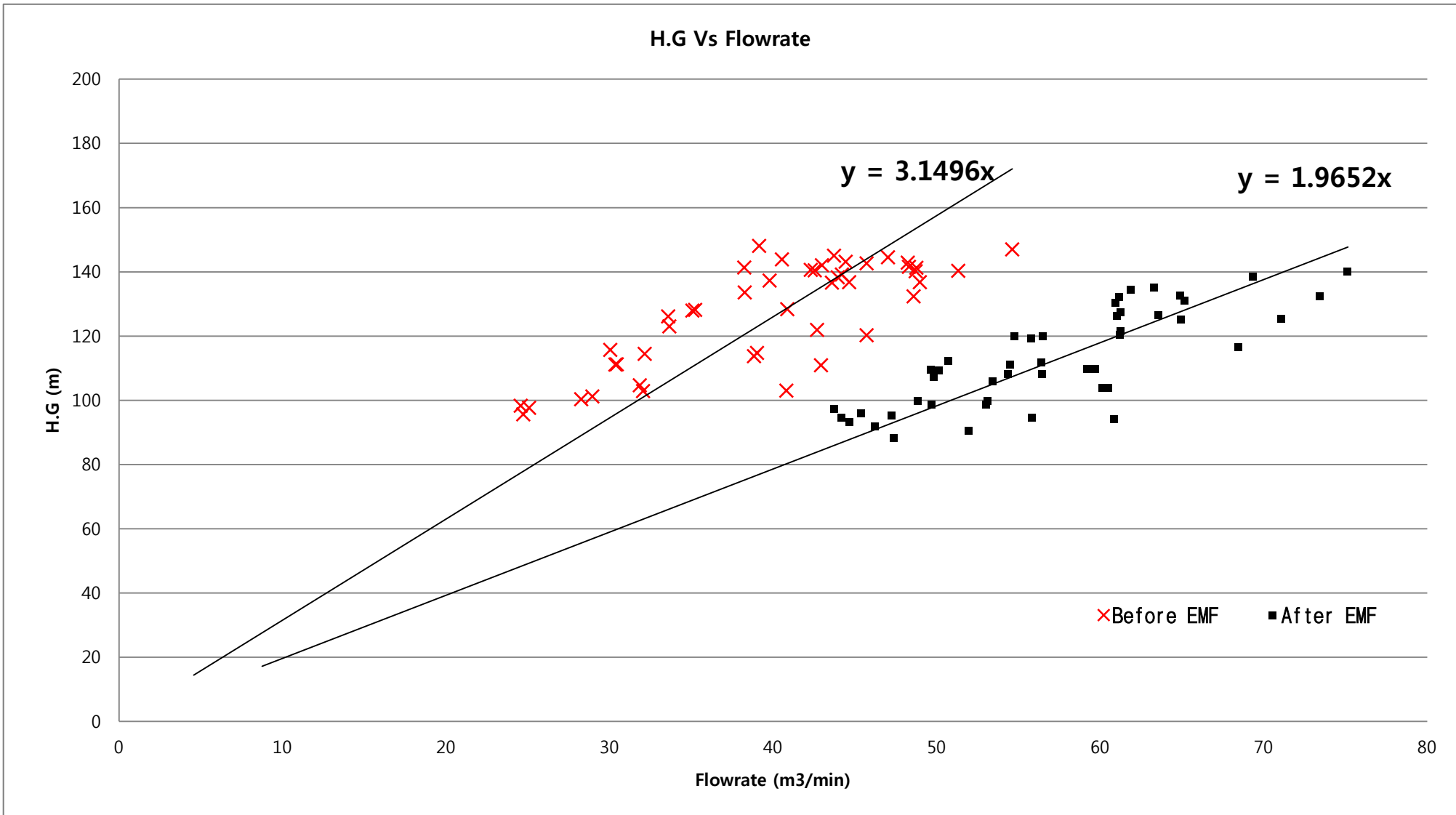
POWER CONSUMPTION VS FLOWRATE

Total Power Vs Flowrate



HYDRAULIC GRADIENT VS FLOWRATE

Area
Cost
Measurement
Group



5. CONCLUSION

CONCLUSION

	Hydraulic Gradient (m)	Flowrate (m ³ /min)	Density (kg/m ³)	Fluid Velocity (m/sec)
Before	336	55.78	1.16	2.64
After	318	69.73	1.21	2.5
Ratio(%)	5.38	25.0	3.73	-5.43

- ✓ Achieve the Dredged soil transportation TEST over 12km under the fixed operating condition
- ✓ Under the EMF condition, Flowrate(Density flowrate) increased over 25% under same power consumption.
- ✓ Expect, It can save the power consumption of Dredger over 25% during same quantity dredged soil transportation.

THANK YOU!

Where there is a will, there is a way!