REDUCTION OF THE EMISSIONS FOR TRAILING SUCTION HOPPER DREDGES

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Contents

Introduction: Problem Description

- Restrictions on emission pollution
- Environmental Protection Agency (EPA)
  - Adopted International Maritime Organisation (IMO)
    - reduce CO_2 by 40% by 2030 and 50% by 2050 compared to 2008
    - reduce NOx (currently Tier III)
    - reduce SOx (currently 0.1% m/m)
- Better understand the current emission profile

Introduction: Research Questions

- Main Questions:
  - What is the total emission profile for THSDs during operations?
  - What are viable methods to reduce their emissions?

  - Emission model
  - Research into emission reduction methods

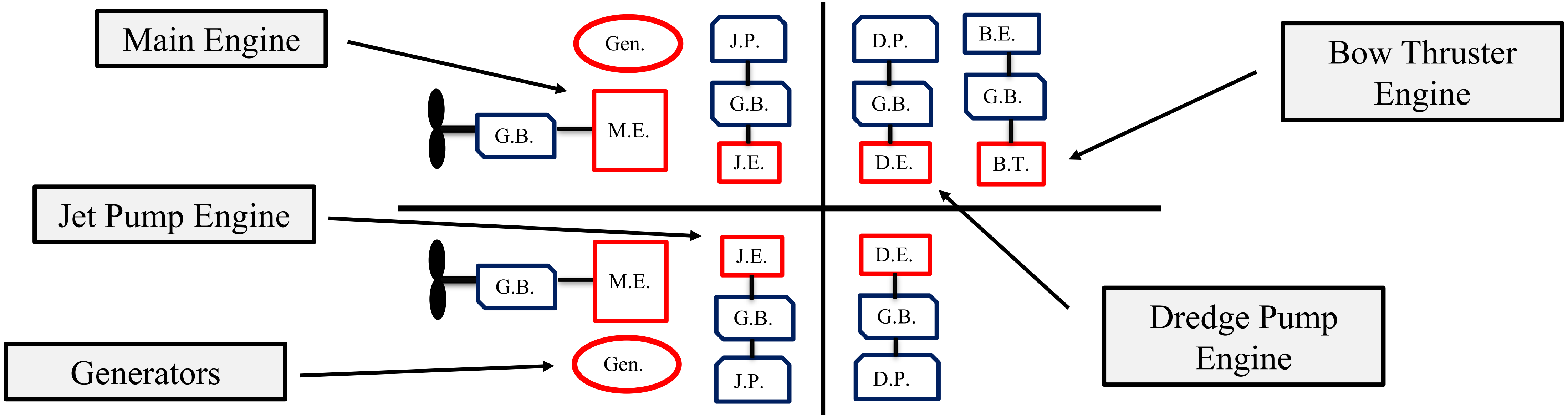
Emission Model

Methods: Emission Model

- Input
  - **Dredge**: Dimensions and specifications
  - **Visor type**: Fixed or floating visor
  - **Discharge method**: Discharge by pipeline or discharge by bottom dumping
  - **Power arrangement**: Direct drive or Combined drive
  - Job specifics – i.e. sail distance
  - Speed and acceleration
  - Discharge specifics – i.e. grain size / pipeline length

Introduction: Working Principle

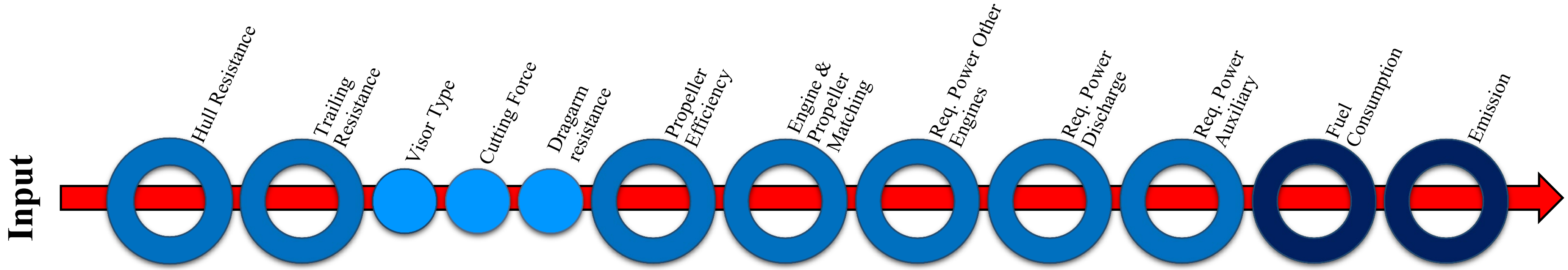
- Mechanical: Direct power arrangement dredge 1



Phases	Auxiliary	Pumping	Manoeuvring
Loading	Gen	JP & DP	ME
Transit Loaded	Gen		ME
Connection	Gen		ME & BT
Discharge	Gen	JP & DP	ME
Disconnect	Gen		ME & BT
Transit Empty	Gen		ME

Methods: Emission Model

- Main parts
  - Hull resistance
  - Trailing resistance
  - Cutting Forces / Resistance
  - Propeller efficiency
  - Engine & propeller matching
  - Required power other engines
  - Required power discharging
  - Required power auxiliary
  - Fuel consumption
  - Emissions



Methods: Emission Model Total Trailing Resistance

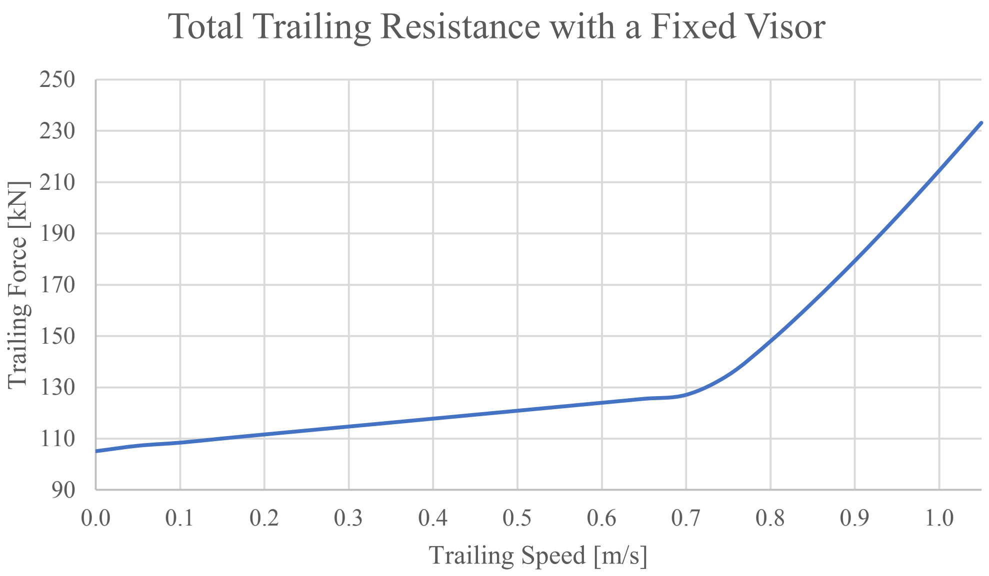


Figure 9: Total Trailing Resistance Fixed Visor
source: Emission Model

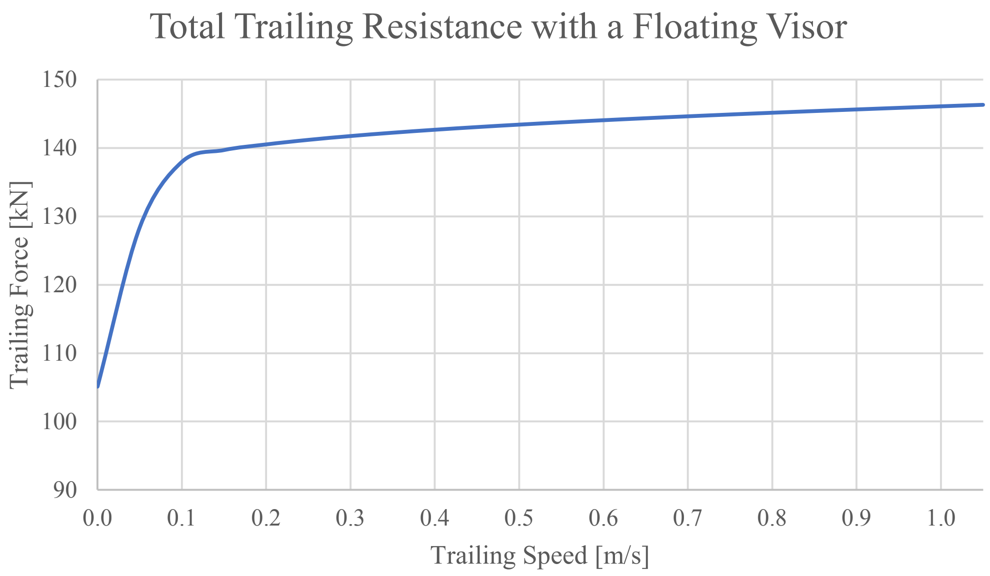


Figure 10: Total Trailing Resistance Floating Visor
source: Emission Model

Methods: Emission Model Overview

Job Specifics		
Amount to be Dredged	768135	m3
Density Soil Hopper	1,95	ton/m3
Dredging Depth	12,8	m
Water Depth Sailing	12,8	m
Minimum Water Depth Sailing	7,0	m
Distance with Min. Water Depth	1000	m
Water Density	1,0253	ton/m3
Estimated Soil Density	15	blows/foot
Fixed Visor Min Angle	40	deg
Fixed Visor Max Angle	50	deg
Sailing Distance (one way)	5093	m

Discharge Method	Pump
Visor	Floating
Dredge	
Power Arrangement	Direct

Discharge		
Length Discharge Pipe	875	m
Line Speed Discharging	4,39	m/s
Discharge Pipe Diameter	30	inch
Discharge Density	1,296	ton/m3
Loading Line Speed	5,9	m/s
Speeds		
Speed Loading Average	0,91	knots
Speed Transit Loaded	9,50	knots
Speed Transit Empty	10,50	knots
Acceleration		
Acceleration Loaded	58	kn/h
Deceleration Loaded	-46	kn/h
Acceleration Empty	74	kn/h
Deceleration Empty	-85	kn/h
Fuel Specifications		
Heating Value	45640	kJ/kg
Price	541	$/m3
Density	0,846	ton/m3
Daily Data		
Fuel Consumption	4134	GPD

Results per Operation		
CO2 Emissions	**3,48**	**kg/m3**
SOx Emissions	**6,34**	**g/m3**
NOx Emissions	**21,27**	**g/m3**
Fuel Consumption	**1,32**	**L/m3**
Fuel Costs	**0,72**	**$/m3**
Carrying Capacity	3821	ton
Hopper Size	2754	m3
Light Ship (weight incl. wate	3164	ton
Amount per Cycle	1809	m3
Nr of Cycles to Completion	425	
Nr of Days to Completion	56,1	
Nr ofCcycles per Day	7,6	
Estimated Euel Consumptio	3983	GPD
Offset versus Daily Data	-4%	
Overflow Percentage	10%	

1. Load Dredge

2. Load P.A.

3. Load Visor

4. Load Propeller

5. Load Discharge

Calculate All

Methods: Emission Model - Output

CO_2 emissions (kg/m3)

SOx emissions (g/m3)

NOx emissions (g/m3)

Fuel Consumption (L/m3)

Fuel Costs ($/m3)

All values in terms of m3 dredged material

Results: Emission Model

- Multiple variations between theory and practise
- Adjustments model
  - Total resistance dredge increased by 10%
  - Specific fuel consumption engines increased by 10%

Job	Daily Data	Emission Model	Unit	Offset
#1	11.24	11.29	L/min	+ 0.4%
#2	11.64	11.23	L/min	- 3.7%
#3	11.30	11.27	L/min	- 0.3%
#4	10.88	10.46	L/min	- 4.0%

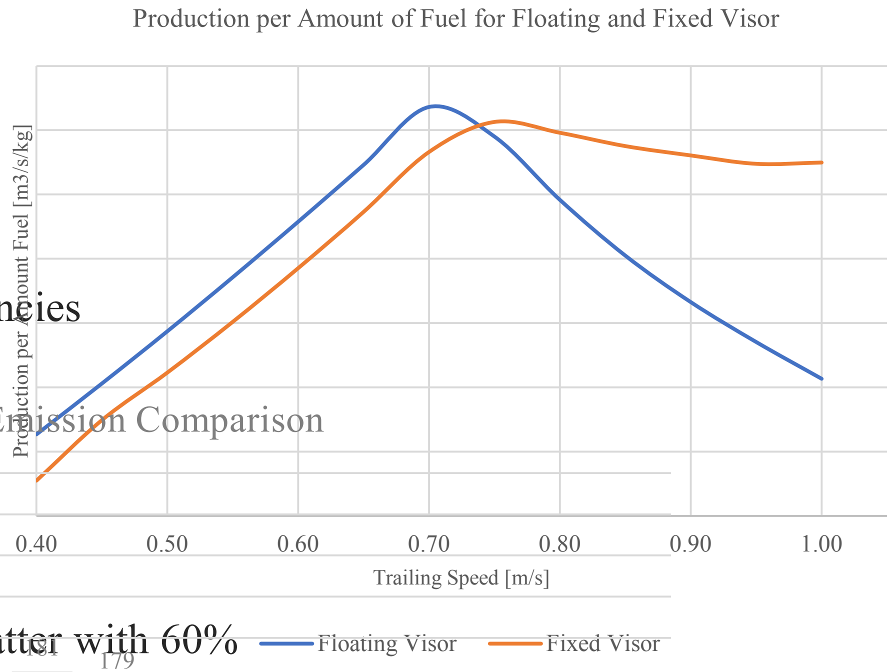
Emission Reduction Methods

Methods: Emission Reduction Methods

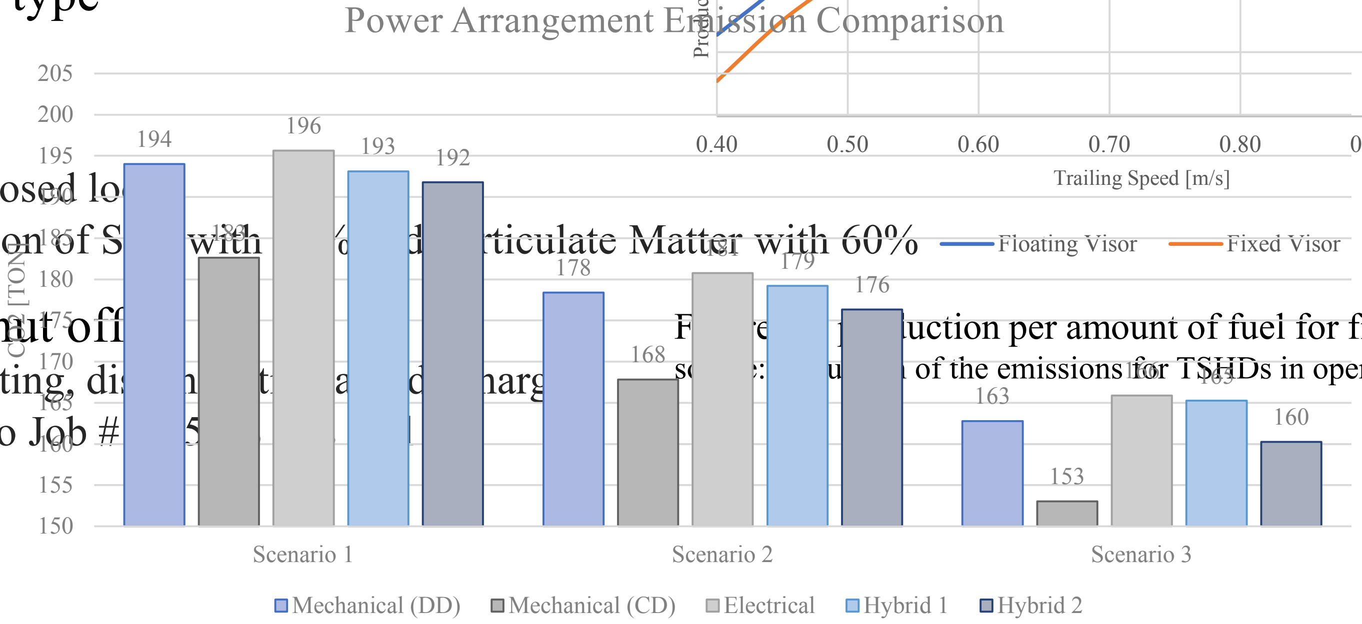
- Model Related
  - Optimal trailing speed (Production versus Fuel Consumption)
  - Optimal sailing speed (Speed versus Fuel Consumption)
  - Prediction
    - Exchange of engines and parts
    - Draghead configurations
    - Propeller pitch
- Practical
  - Power arrangement
  - Propeller type
  - Scrubbers
  - Engine shut off

Results: Emission Reduction Methods

- Optimal trailing speed
  - 0.70 m/s (1.36 knots)
- Power arrangement
  - Mechanical: Combined Drive
  - Lower sfc with larger displacement engine
  - Mechanical less components with less inefficiencies
- Propeller type
  - CPP
- Scrubber
  - Wet: Closed lo
  - Reduction of S with % d rticulate Matter with 60%
- Engine shut off
  - Connecting, di n t a d harg
  - Scenario Job # 5



F re uction per amount of fuel for fixed and floating visor
s e: u of the emissions for TSHDs in operation, D. de Roode



Conclusion

- Emission Model
  - Multiple causes of variations between model and practise
  - Accuracy within 4% on L/min
  - Possibilities for expansion, i.e more drive types / engine profiles
  - Possibilities for increasing accuracy
- Emission Reduction Methods
  - Model and practise based
  - Reduction emission possible
  - Further research recommended

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