Deck Machinery for Research Vessels: Energy Efficiency

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Electric vs. Hydraulic Drive

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Electric vs. Hydraulic Drive

- Energy regeneration
- Energy transfer efficiency
- Consumption only during operation
- Control efficiency
- Overload and overspeed capability
- Environmental factors
- Maintenance
- Remote assistance, data logging and analysis

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Electric vs. Hydraulic Drive

	HYDRAULIC	ELECTRIC
INSTALLATION COSTS	≈	≈
CAPEX	100%	110%
WEIGHT	≈	≈
POLLUTION RISK	Oil leakages	No Risk
NOISE	Moderate	Very Low
MAINTENANCE	Replacement of Valves, Block, Heating, Oil, etc.	Minimal moving parts, Electric parts are more standardised and easy to replace
CONTROLS	Affected by oil inertia, stepped control	More sensitive, faster response. Progressive control 0-100%
EFFICIENCY	60%	95%

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Electric vs. Hydraulic Drive

- Electric drive

Type	Qty	P (kW)	Pull (t)	Speed (m/min)	Frequency Converter	Overload	Overspeed	Pt (kW)
Trawl Winch	3	370	54,1	34,6	Yes	30%	100%	1.080
Gilson	3	75	21,5	23,9	Yes	30%	40%	225
Sweepline	8	75	21,9	19,7	Yes	30%	50%	600

- Hydraulic drive

Type	Qty	P (kW)	Pull (t)	Speed (m/min)	p (bar)	Q (l/min)	Pt (kW)
Trawl Winch	3	453	53,1	34,8	210	1.100	1,359
Gilson	3	127	24,6	21	185	350	381
Sweepline	8	109	22,2	20	185	300	871

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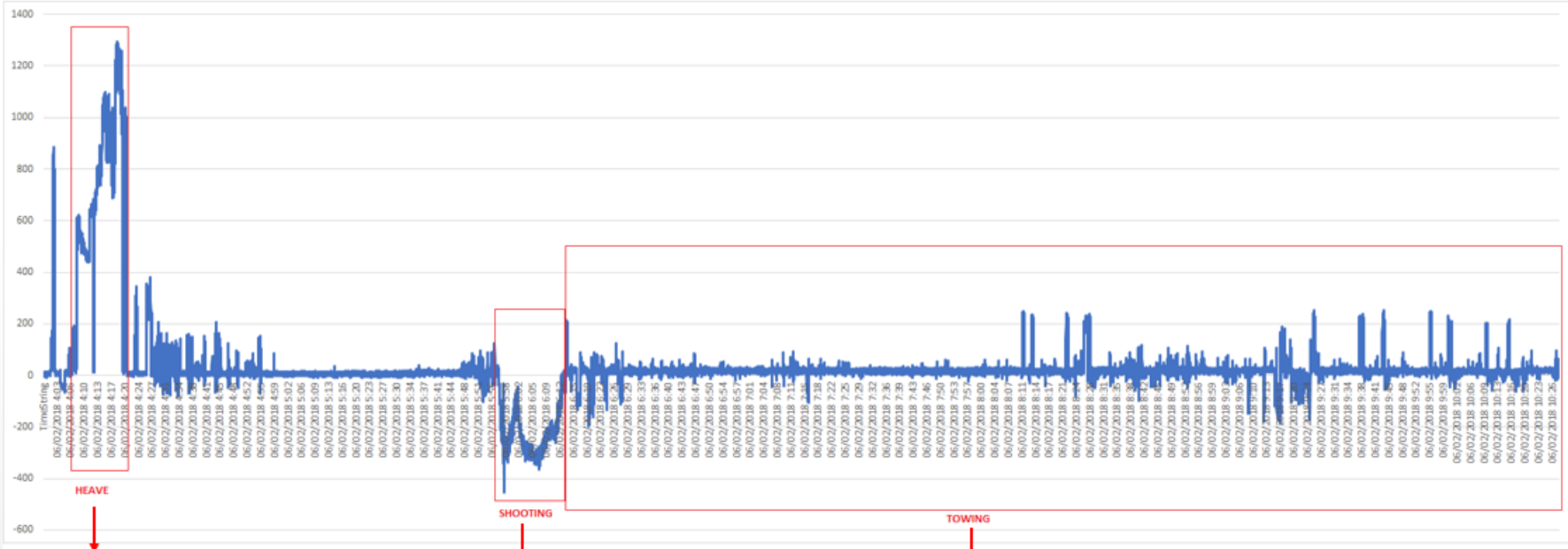
Electric vs. Hydraulic Drive

- **Data from real trawl operation**



Electric: 3x290 kW
Hydraulic: 3x350 kW
Time: 13 min

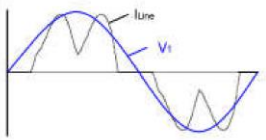
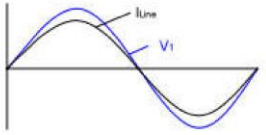
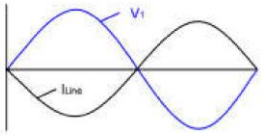
Electric: 3x130 kW
Hydraulic: 3x176 kW
Time: 15 min

Electric: 3x15 kW
Hydraulic: 3x160 kW
Time: 240min

Electric drives

- Basic Line Module (BLM) requires brake resistors, only recommended if insufficient consumers onboard
- Smart Line Module (SLM) allows regeneration, directly to vessel network
- Active Front End (AFE) allows for regeneration of energy, but with greatly reduced harmonics

Active Front End (AFE): The Active Infeed is an actively pulsed, stable, regulated rectifier / regenerative unit for four-quadrant operation, i.e. the energy flows from the supply system to the DC link and vice versa.

	Motor operation	Regenerative operation
S120 Basic Infeed 6-pulse		Regenerative operation is not possible
S120 Active Infeed with cosφ=1 according to factory setting		

AFE is the optimum solution.

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Winch dimensioning

Winch dimensioning

- Trawl winches offer greatest benefits, high powers leading to greater regeneration
- With lower power requirements, regeneration for scientific vessel is less significant
- Correct dimensioning saves weight and power requirements
- Overload and overspeed functions very important

Winch dimensioning

ENERGY EFFICIENCY = ACCURACY/PRECISION

- Weight Decrease

- Losses are a %

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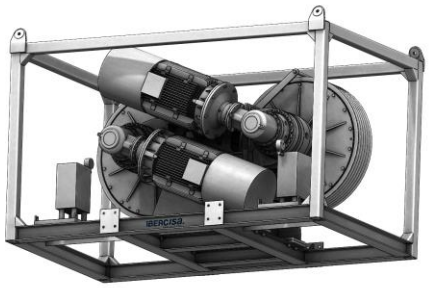
Winch configuration

There are two types of winch design for piston coring:

- Direct pull winches → < 6km =< 15m piston corer

- Traction winches → > 6km > 15m piston corer



Overload capacity

- Overload and overspeed functions very important: allowing the potential to reduce motor sizes. Working with the overload function, we can achieve a 32% higher power output for a limited time.

Payload Piston Corer	1.500 kg
Estraction effort Piston Corer	4.000 kg

Haulback Performances

Layer		Nominal 90 kW S1 service		Overload 104 kW 15% Continuous 30'		Stall Load 119 kW 32% Intermitent 1' each 5'	Overspeed 90 kW 65% Continuous		Max. Light line speed
		pull	speed	pull	speed	pull	pull	speed	speed
		tons	m/min	tons	m/min	tons	tons	m/min	m/min
First	1	9,0	0 - 56	10,3	0 - 56	11,8	5,4	0 - 92	101
Half	14	6,0	0 - 84	6,9	0 - 84	7,9	3,6	0 - 138	151
Full	27	4,5	0 - 112	5,2	0 - 112	5,9	2,7	0 - 184	201

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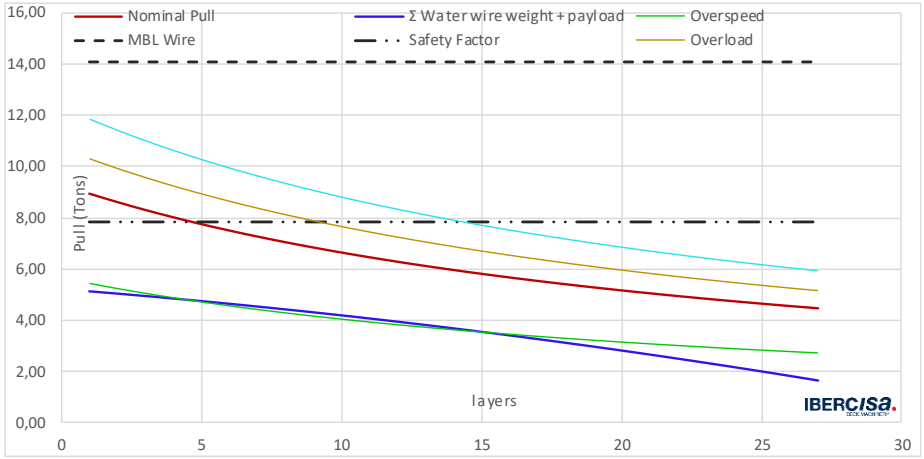
Overload capacity

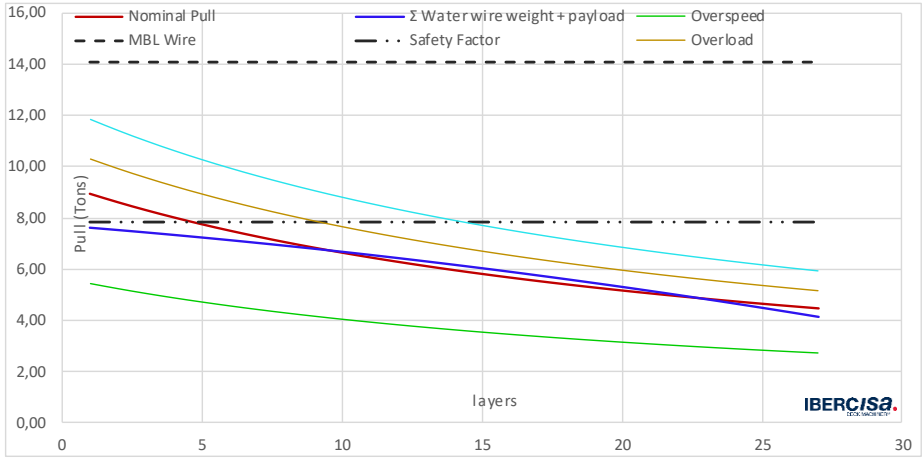
Overload capacity for piston coring



Payload	1.500 kg
Piston Corer 15m	

Safety Factor (1st layer)	**1,6**
Safety Factor (Last layer)	**3,1**

Deployment @ 0m-6000m



Extraction Effort	4.000 kg
Piston Corer 15m	

Safety Factor (1st layer)	**1,6**
Safety Factor (Last layer)	**3,1**

Extraction @ 0m-6000m

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Wire selection

Wire selection to improve efficiency

PERMANENT LOADS

4000m x 14mm steel wire – 3500kg in seawater

Steel wire

3500kg + payload of 2000kg + hydrodynamic factor 1000kg = 6500kg

Motor power requirement 70 kW

4000m x 14mm synthetic rope – 400kg in seawater

Synthetic rope

400kg + payload of 2000kg + hydrodynamic factor 1000kg = 3400kg

Motor power requirement 37 kW

Almost 50% reduction in motor requirement

Synthetic rope implies significant reduction in cable and winch weight, power and winch structural requirements, electric drives, etc.

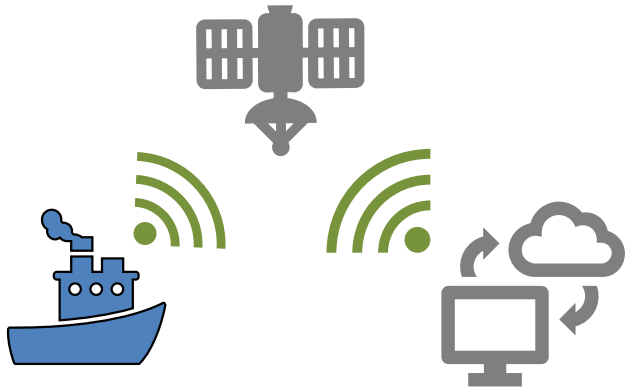
Existing and future technologies

Data logging and remote assistance

- Data logger
- Cloud computing with HMI
- Alarms can be generated to alert owners to energy consumption, required maintenance, etc.

- This allows most small incidents to be solved in short time with remote connection.

- Data analysis of previous operations can help improve performance of the equipment and optimise operations



Existing and future technologies

Permanent magnet technology

- Slightly higher efficiency that asynchronous motors
- Significantly higher initial cost