MudMaster™

Real-Time Mud Analysis

ABLE MudMaster™: Drilling Mud Outflow Analyser for measurement of drilling fluids in partially full pipe conditions

During Oil & Gas drilling operations, drilling fluid (mud) is pumped into the drill string to stabilise the well bore, remove cuttings and cool the drill bit. Maintaining proper density of the fluid is imperative to ensure downhole pressure is correctly managed, whilst accurate measurement of flow rate entering and exiting the well provides assessment of drilling performance and indication of a potential well control event.

Using non-contact and non-intrusive technologies, the ABLE MudMaster™ measures the mud flow in the gravity fed mud return flowline under all partially full flow conditions, giving accurate and repeatable real time measurement of mud during drilling operations.

The fully augmented MudMaster™ mud drilling analyser system incorporates the ABLE MudMaster Mudin™ Coriolis mass analyser on the mud inlet flow line for accurate, real-time mass balance measurements with automatic time delay compensation for well depth. Furthermore, the Mudin™, as with all of the ABLE Master Series of metering products, applies an enhanced layer of analytics to the data generated by the sensors on the inlet to furnish the operator with advanced diagnostics regarding the rheological properties of the mud and general drilling fluids performance. See schematic MMMBFMS (attached)

These measurements provide invaluable information for drilling optimisation and identifying leading indicators to potential imbalanced operating problems, such as lost circulation or 'kicks'.

The ABLE MudMaster™ independently measures flow and density using a development of established measurement techniques to produce reliable, accurate and repeatable real time data. The instrument is spool mounted to bolt directly into the outlet pipe and the non-contact nature of the technologies employed provides no restriction to mud flow, zero pressure drop and no moving or process contact parts subject to wear or requiring maintenance.

Typical MudMaster™ installation on a 12" gravity fed outlet flow line

ABLE MudMaster™ provides invaluable information for drilling optimisation

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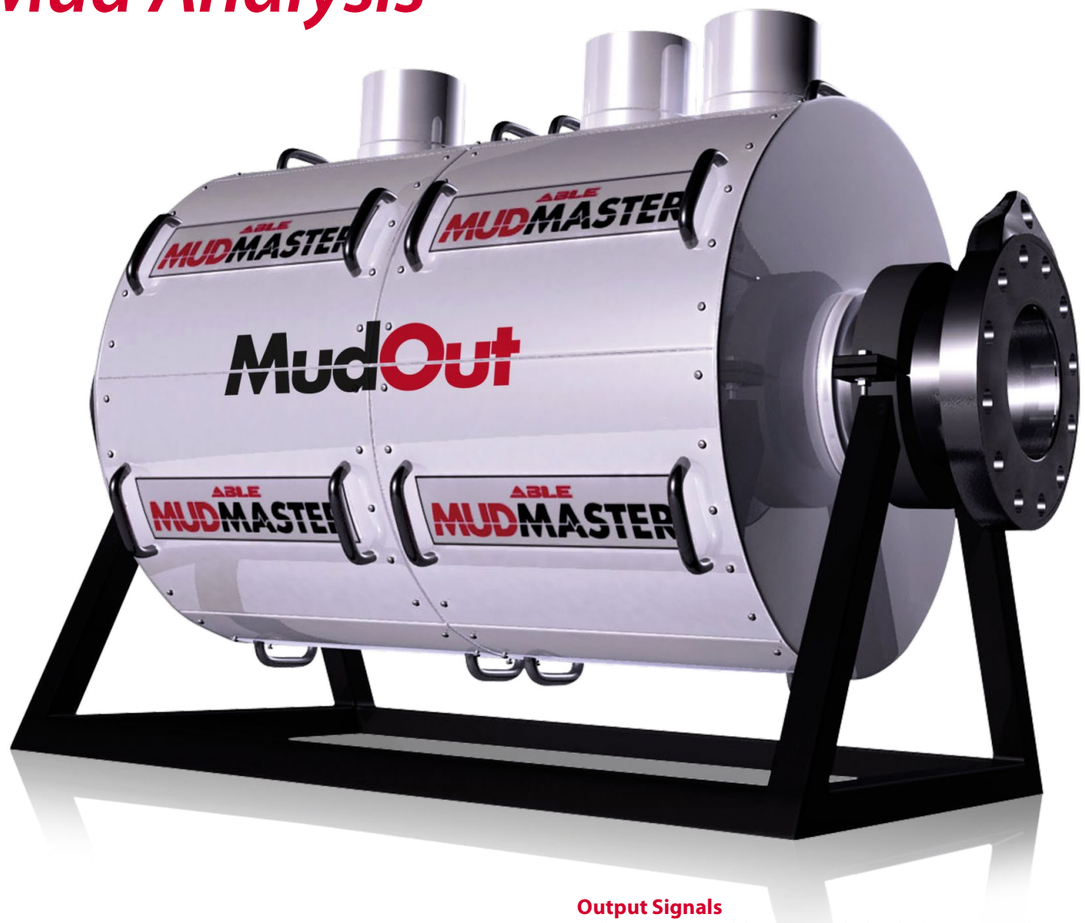


UK Patent Number: GB2481666

US Patent Number: 8,965,713

SPECIFICATIONS

Applicability

Liquids	Any mud liquid mix including entrained gas and solids
Operating Temperature	Standard -40°C to +85°C
Spool Sizes & Materials	Available in various spool sizes and materials as required (Standard example 12" schedule 40 carbon steel)

Measurements & Ranges

	UNITS	RANGE
Volumetric flow	GPM	0 – 1320
	m3/hr	0 – 300

(fully programmable outputs offering all units available per day/hr/min/sec)

Mass Flow	T/hr	0 – 660
	Te/hr	0 – 600

(fully programmable outputs offering all units available per day/hr/min/sec)

Density	PPG	0 – 16.7
	SG	0 – 2
	kg/m3	0 – 2000

(fully programmable outputs offering all units available)

Temperature Measurement	°F	32 – 212°
	°C	0 – 100°
Partially Full Operation	Level	0 – 100%
Operating Temperatures	°C	-40 to +85°
Mud Types	Oil based mud Water based mud	

Detector/Sensor Type

Multiple sensor array including:

- Ultrasonic
- Radiometric
- Microwave
- Pressure
- Temperature

Performance

• Density ±2% • Volumetric flow ±2%
• Mass flow ±3% • Temperature ±2%

Response Time

Real time measurements (data updates every 0.5 seconds)

Output Signals

Fully programmable industrial plc platform, providing:

- Current & voltage loops
- Modbus
- Profibus
- Any recognised protocol available on application

Input Signals

Analogue or Modbus from inlet mass flow meter and temperature sensors for automatic mass balance calculation with well depth compensation

Power

24VDC
Consumption = 2.5 amps on start-up, 1.5 amps on operation

HMI Software Suite – Key Event Recognition & Measurement Parameters

- Mass Balance & Kick Detection
- Cementing Operations
- Live Gains from Formation and Ballooning
- Live Losses to Formation
- Evaluation of Live Gas and Solids Concentration
- In-Hole Cleaning Operations

Certification

Meter spool ATEX Zone 1. Control panel available in Zone 2 and Zone 1 build options

Weights & Dimensions

See drawing MM100001 (attached)

Connections

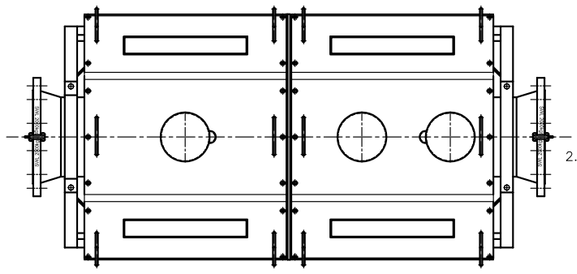
- Class 150LB RF, Schedule 40. Weldneck Flange 12" NB., ASME B16.5
- Seamless Pipe 12" NB. Schedule 40 (323.9mm O/D x 10.31mm thick wall

Additional available features

- Inlet to outlet balance for measuring formation losses, underbalance and poor caking
- Trip in/trip out drill distance calculations

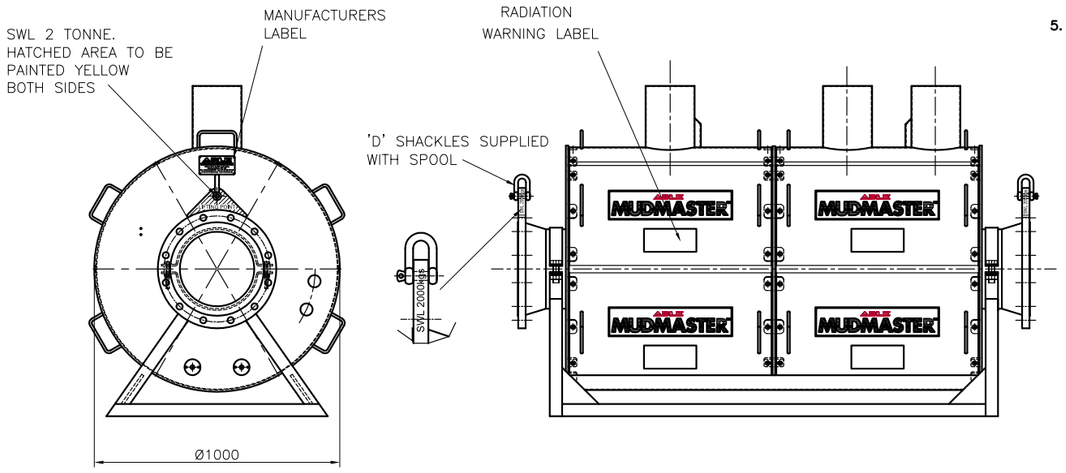
Operation Summary and Features

- For gravity fed mud outlet flow lines
- Fully non-intrusive, non-contact technologies with no flow restrictions or obstructions
- Measures accurately during continually partially full pipe operation
- Mass flow with independent volume flow and density measurements
- Designed for non-pressurised gravity fed lines
- The option of ABLE's MudMaster Mudin™ high pressure Coriolis Mass Analyser on the mud inlet flowline provides a fully integrated mud mass balance measurement system. See schematic MMMBFMS (attached)



NOTES

1. THE SPOOL SHALL BE FABRICATED IN ACCORDANCE WITH ASME B31.3, 2010 EDITION. ALL MATERIALS AND WELDS SHALL BE SUBJECTED TO NON DESTRUCTIVE EXAMINATION (NDE), IN ACCORDANCE WITH ASME V AND ASME B31.3. THE ACCEPTANCE CRITERIA FOR ALL NDE SHALL BE ASME B31.3, NORMAL FLUID SERVICE. ALL NDE SHALL BE PERFORMED BY PERSONNEL QUALIFIED TO EN 473 LEVELS 2 OR 3 ONLY.
   THE NDE REQUIREMENTS SHALL BE AS LISTED BELOW.
   ALL MATERIALS AND ALL WELDS : 100% VISUAL INSPECTION
   ALL BUTT WELDS : 100% RADIOGRAPHY INSPECTION
   ALL CARBON STEEL WELDS : 100% MAGNETIC PARTICLE INSPECTION
   ALL STAINLESS STEEL WELDS : 100% DYE PENETRANT INSPECTION
2. THE SPOOL SHALL BE SURFACE COATED IN ACCORDANCE WITH THE ABLE INSTRUMENTS SURFACE COATING SPECIFICATION, DOCUMENT NUMBER PR100033 REV 8. THE COATING SYSTEM USED SHALL BE B1, OR THE EQUIVALENT, AND THE FINAL TOP COAT COLOUR SHALL BE WHITE TO BS 4800 SHADE 00 E 55, OR RAL 9010.
   HATCHED AREA TO BE YELLOW BS4800 SHADE 10 E 50 OR SIMILAR BOTH SIDES & TOP. (TO INDICATE LIFT POINT)
   PLEASE NOTE THAT ALL NON CARBON STEEL COMPONENTS SHALL NOT BE PAINTED.
3. SPOOL TO BE PRESSURE TESTED TO 2 BARG, FOR 15 MINUTES.
4. ESTIMATED WEIGHT OF SPOOL ASSEMBLY IS 825 KGS ESTIMATED.
5. **LIFTING WARNING:– SWL 2000KGS. LIFTING POINTS ARE DESIGNED FOR THE PURPOSE OF LIFTING THIS SPOOL AND NOT FOR LIFTING ANY ADDITIONAL ATTACHED LOADS.**



3	REFER TO MN0000850 (AS BUILT)	JW	22/07/13
2	REFER TO MN0000779	APS	20/06/12
1	ORIGINAL DRAWN: MRH CHECKED: APS	RMB	16/04/12
ISSUE	DESCRIPTION	APP'D	DATE

3rd ANGLE PROJECTION | DO NOT SCALE IF IN DOUBT ASK | SCALE: NTS

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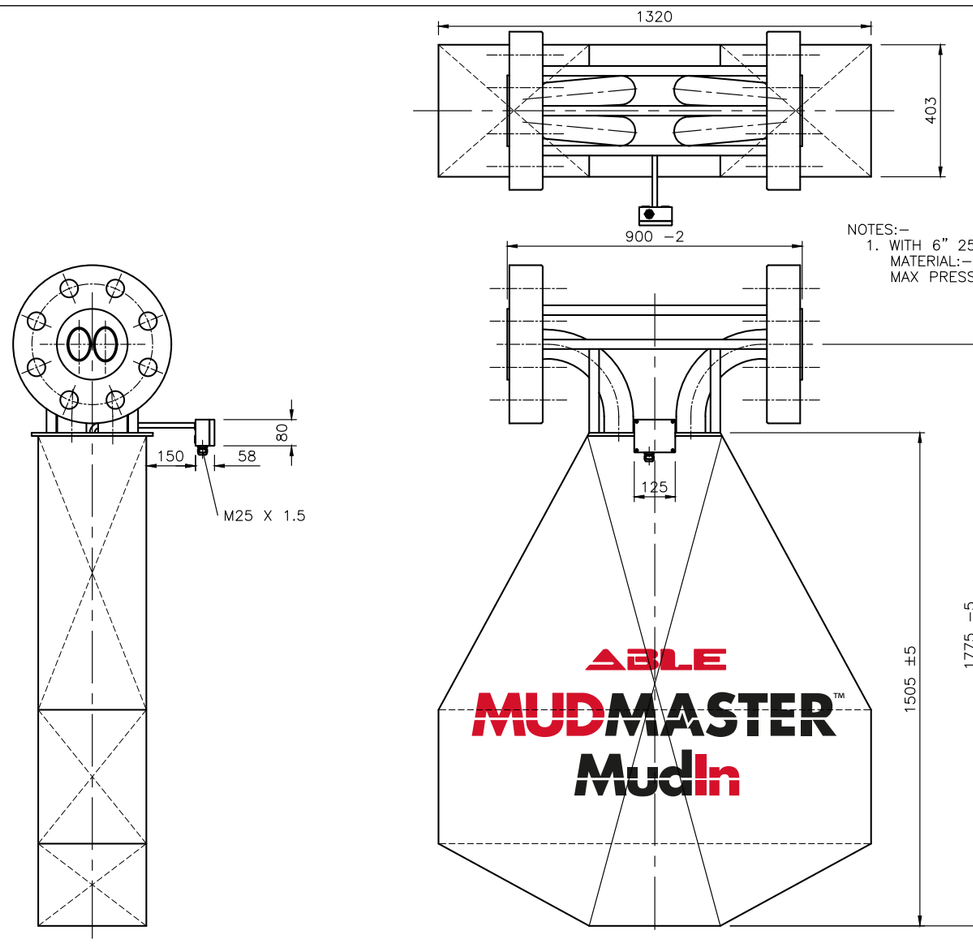
CUSTOMER: N/A
CONTRACTOR: N/A
P.O. No.: N/A
ABLE REF.: N/A
PROJECT: N/A
FILE PATH:– \CADDATA\CUSTOMER\MM

TITLE: INSTRUMENT INDICATOR/ SPOOL FOR MUD FLOW MEASUREMENT

DRG No. MM100001 | SHT. 1 OF 4



1	ORIGINAL DRAWN: MRH CHECKED: RMB	DQ	16/07/18
ISSUE	DESCRIPTION	APP'D	DATE

3rd ANGLE PROJECTION | DO NOT SCALE IF IN DOUBT ASK | SCALE: 1:12

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CONTRACTOR: N/A
P.O. No.: N/A
ABLE REF.: N/A
PROJECT: N/A
FILE PATH:– \CADDATA\CUSTOMER\MM

TITLE: MUDMASTER MUDIN™ MASS FLOW ANALYSER

DRG No. MM100014 | SHT. 1 OF 1

For more information on Mudin™ please visit able.co.uk

Schematic: MMMBFMS

MudMaster™ Mass Balance Flow Metering System