

## Norms and Standards for sizing and calculation of a

## **Coke Cutting System**



## Düsseldorf

October 19th - 21st 2011

Dr. Wolfgang Paul RUHRPUMPEN GmbH



## RUHRPUMPEN

### Agenda

- 1. Introduction
- 2. Tendencies
- **3.** Norms and Standards for Lifting System
- 4. Calculation of Coke Cutting Lifting System
- 5. Main Components of the Cutting System
- 6. Control System
- 7. Auxiliaries





## **Decoking System**

NO Norms and Standards for Sizing and Calculation of Coke Cutting Lifting Systems in licensor specifications

Project Situation EPCs: "Just technical acceptable" "No Bonus for technical advantages" "Lowest possible price"

Reported increased failure rate at large cokers

Coke Cutting System Specifications do NOT Reflect actual Industry Standards



## **Decoking System**



## endency in Coke Drum Size



5

RUHRPUMPEN









Hoist pull force related to drum size and jet pump power







## **Definitions**

• Lifting System

۲

All Components for lifting and lowering weight including safety devices, instruments and controls

ifting System

Cutting System: Arrangement of all components Hoists with gear, motor and brakes with foundation, anchor bolts safety devices (press roller, slack rope device) Ropes / Wires Pulley Blocks with foundation, anchor bolts Crosshead with Free Fall Arrestor devices Control System designed for remote/autom. op.

RUHRPUMPEN







#### **Definitions: Operation**

Pull Force, design - required

- Pull force, weight to lift of cutting system components
  - including water
  - including dynamic forces due to operation
- + Safety Margin, variable for Stuck Tool Situation
  - for Coke Fall down
- + Efficiency of Rope / Reeving System
  - Max operationmax pull force at normal operationMax max operationstuck tool operation at reduced speed
- Pull Speed, designTime for complete lift from MIN to MAX position- required( Definition by licensor,<br/>with influence on cutting time )





### Specifications Hoist, Gears, Ropes, Pulleys, ....,

Lifting System

•	ISO 4301/1	Cranes and lifting appliances,	1986-06-15, 2 <sup>nd</sup> edition
•	ISO14492-1	Power driven winches and hoists	2007-02
•	EN 13001-1:2004	Cranes . General design . Part 1: General principles and requirement	2004 s;
•	ISO 10425	Specification for wire ropes	2003
•	ANSI / API 9A	Steel wire ropes for the petroleum and natural gas industries	2004-02, 25 <sup>th</sup> edition
•	API RP 9B	Recommended practice on application care and use of wire rope for Oil Field Serv	2005, 12 <sup>th</sup> edition ice

RUHRPUMPEN Specialist for Pump Technology

10



## Specifications

• ISO 4301/1

ISO14492-1

Cranes and lifting appliances, Power driven winches and hoists

System - Hoist

1986-06-15, 2<sup>nd</sup> ed. 2007-02

RUHRPUMPEN

#### Classification of Winch acc. ISO14492-1 and ISO 4301/1\_

Calculated Load spectrum factor (acc. Equation 4) Choosen Nominal Load spectrum factor Km (acc. Table 5) State of Loading (acc. Table 5) Class of utilization of mechanism Total duration of use (acc. Table 4) . Group Classification (acc. Table 6) .

Classification of Winch-Gear

Light duty XL (26)	Heavy duty XXL (32)
0,21	0,21
0,25	0,25
L2- Light moderate	L2- Light moderate
Т5	T7
6300h	25000h
M5 / L2 / T5	M7 / L2 / T7
M5 / L2 / T5	M7 / L2 / T7



#### **Specifications**

Drum (Hoist), Diameter		(API RP 9B, §4.5, pg 15)					
D min =	20 x d rope, d = 16 mm d = 18 mm	x d rope,D recommended: 16 mmD min = 320 mm: 18 mmD min = 360 mm		= 100 x d rope D recom = 1600 mm D recom = 1800 mm			
RP	d = 16 mm d = 18 mm	D D	= 500 mm = 500 mm	D/d = D/d =	31,25 27,8		

String System - Hoist

Grooves required for safe rope spooling with ensuring of rope life time acc. ISO 4301/1, EN 14492-1 acc. API RP 9B



RUHRPUMPEN Specialist for Pump Technology

RUHRPUMPEN



### **Specifications**

Sheave-Rope Diameter Ratio Efficiencies of Wire Ropes Bent Around Stationary				acc. API RP 9B) pg4. Fig Sheaves			
	D/d =600mm/16mm D/d =600mm/18mm	n = 37,5 n = 33,3	eff. = 97, eff. = 96,	,0% ,5%	RP RP	with large impact to life time of wire ropes	
	D/d =300mm/16mm	n = 18,75	eff. = 92,	,0%	others		
Seizing	<b>of sheaves</b> <i>F</i> sheave-diameter fa Rope 6x37	ctor, F = 33	following selected f case A,	g formula a from Table 5 selected b	applies: 5. y RP	<i>DT</i> = <i>d x F</i>	
	d= 16 mm			DT = 16 x 3	33 = 528 m	nm	
	d= 18 mm		I	DT = 18 x 3	33 = 594 m	nm	

ifting System – Pulley Block



13

RUHRPUMPEN



# RUHRPUMPEN

#### **Specifications**

Efficiency of wire

acc. API RP 9B) pg 5 fig 2

wire rope reeving with multiple sheave blocks K=1,09 Case A: N=4, S=4 eff= 0,810 Case B: N=4, S=5 eff= 0,743

Fast L fac = 0,309 Fast L fac = 0,336





## Cutting equipment

#### **<u>Calculation of Pull Force</u>** (RP recommendation)

- Weight of Cutting Equipment
- = Pull Force at Hoist, PF-H
- + Operation and Safety Margins
  - Efficiency API 9B, 0,80%, 4 sheaves
  - Margin for stuck tool on PF-H: 1,50 for Drum D < 26ft</li>
  - 1,50 for Drum D => 26ft
- = Design Pull Force of Hoist @ Design Pull Velocity
   PF-Hoist-design
- Design Pull Velocity of CH from Flange to Flange
   PV-CH-design: 3 minutes

Dr. W. Paul, 2011-02

RUHRPUMPEN





## **Cutting equipment**

<u>C</u>	alculation	D > 26ft	D => 31ft
•	Weight of Cutting Equipment	RP	RP ( <u>&gt;</u> 32')
	DSD / Rotary Joint	1.670 kg	1.670 kg
	CH / FFA	840 kg	840 kg
	<ul> <li>Rope, 18 mm</li> </ul>	207 kg	259 kg
	• <u>Tool</u>	325 kg	<u>325 kg</u>
	Summary 1	3.042 kg	3.094 kg
	<ul> <li>Drill Stem 7"OD, w water, 78+15 kg/m</li> </ul>	3.720 kg	
	<ul> <li>Drill Stem 8"OD, w water, 98+25 kg/m</li> </ul>		5.535 kg
	<ul> <li>HP-Hose, filled with water</li> </ul>	<u>1.105 kg</u>	<u>1.383 kg</u>
	<ul> <li>Weight of Cutting Equipment (CH)</li> </ul>	7.876 kg	10.012 kg
•	Pull Force at hoist, PF-H, v=0	1.967 kg	2.503 kg
	<b>Operation and Safety Factors</b>		
	<ul> <li>Efficiency API 9B, 0,80%, 4 sheaves</li> </ul>	+ 393 kg	501 kg
	<ul> <li>Margin for stuck tool 1,50 PF-H</li> </ul>	+ 983 kg	1.252 kg
	<b>Design Pull Force of Hoist, PFh-d</b>	<u>3.344 kg</u>	4.255 kg

Dr. W. Paul, 2011-02

16



# RUHRPUMPEN

#### **Calculation: Plant data and required Pull Force**

Safety factor, available at pull force, max max, operation

Plant Data	Light duty XL (26) H	leavy duty XXL (32)	
Drum D	m	8,53	9,75
Drum FF	m	38,10	44,20
Coke drum Volume	m³	0	0
Coke m/drum	t	0	0
Cutting System weight	kg	7.831	10.027
Hoist		FF	
Operation Requirements		Light duty XL (26) H	leavy duty XXL (32)
Pull force at hoist, normal operation	kN	24,01	30,74
Pull force at hoist, max operation	kN	28,81	36,89
Pull force at hoist, max max operation	kN	33,61	43,03
Safety factor at max allow force	required	4,00	4,00
Hoist data		Light duty XL (26) H	leavy duty XXL (32)
Winch Type		DH 4.24-50-T-R	DH 4.24-50-T-R
Max. allowable Pull force at Winch	kN	49,05	49,05
Safety factor at max allow force, required		4,00	4,00

4,56

17

5,84





## Cutting equipment

D	esign	Lifting System			
		metric	imperial		
•	Pull force, max. hoist, static	50 kN	11,240 lbsf		
	<ul> <li>Gear classification FEM, D&lt;26ft</li> </ul>	M5 / L2 / T5			
	<ul> <li>Gear classification FEM, D&gt;26ft</li> </ul>	M7 / L2 / T7			
	<ul> <li>Hoist drum diameter</li> <li>Grooves acc. ISO</li> </ul>	500 mm ( 20")			
•	Pull speed, hoist, 1 <sup>st</sup> / 4 <sup>th</sup> layer	60 m/min	203 ft/min		
•	Rope				
	_ D rope, D <u>&lt;</u> 26ft	16 mm	5/8"		
	<ul> <li>D rope, D&gt;26ft</li> </ul>	18 mm	3/4"		
•	Pulley Blocks				
	- Diameter	600 mm	24"		
•	Free Fall Arrestor System				
	<ul> <li>Design load, certified</li> </ul>	9500 kg	20,945 lbs		
•	Control System	electric, incluc	ling safety system		



## **Cutting equipment**

#### **Calculation**

Derrick

- Pull force, max. hoist, static
   Dynamic factor
- Max. load due to cutting equipment 20
  - Dynamic factor
- Free Fall Arrestor System
  - Dynamic Factor
    - wheel type

50 kN (11,240 lbsf)

RUHRPUMPEN

200 kN (45,000 lbsf)

acting to main beams to structure, not derrick

Dynamic Factor

design rules of steel structure cutting system control design - dampening of start / stop Manual or PLC controlled

> Dr. W. Paul, 2011-02 19



## **Hoist and Rope**



## Hoist with integral cartridge gear

- Grooved drum
- Pull force 5 t
- Triple brake system
- Slack rope device
- Full baseplate
- Safety cage
- Enlarged sidewall
- Pressroller

#### Rope

- Measurement of tension in the rope
- Indication at the operator panel
- Overload protection

RUHRPUMPEN Specialist for Pump Technology







## RUHRPUMPEN

#### • Design

- Electric motor
- 2 x 75 kW
- Hydraulic Pumps
  - Hoist, DSD, circulation
  - Redundant inst.
- Hydraulic oil
  - standard or
  - non flammable
- Container version
  - mechanical protection









#### Cabinet

- 2 x VFDs for Hoists (redundant installation) - Hoist electric motor 2x; 4x; 6x 50 kW
- Hoist Control
- Power supply

Installation in safe or hazardeous area





## RUHRPUMPEN

- Hoist with integral cartridge gear
  - drum with grooves
  - Pull force 5 t
  - slack rope device
    - locks the hoist
- Rope
  - measurement of tension in the rope
  - indication at the operator panel
  - avoiding of overload



23





## **Hoist, Block and Rope**



- Hoist, electric version
  - Pull force 5 t
    - (20 t at crosshead)
  - slack rope device
  - MDMT -45°C
  - ATEX, CSA

#### Rope

- measurement of tension in the rope
- indication at the operator panel
- avoiding of overload

#### Variable Frequency Converter VFC

 Installed in safe area







#### **Pulley Block**

- Single
- Double
- Design load 20t

#### Devices to measure

- Load
- Position
- Speed

Block OD 24" Full Protection Cap







#### **Crosshead with DSD**

- Drill Stem Drive
  - electrically driven
- Free Fall Arrestor
- Pulley Block
- Gooseneck





## RUHRPUMPEN Drill Stem Drive

- Drill Stem Drive
  - Electric motor
  - High load bearing
  - Grease lubrication
  - Cartridge packing

- Swivel

- Standard version
   (+40°C to -20°C)
- (DT down to -50°C)
- Varible Frequency Converter VFC
  - At Cutting deck, or
  - At safe area





## **Drill Stem**

### $D \le 20'$ ( 6,0 m),

- Diameter of Drill Stem
- Threaded
- Welded

### D ≤ 30' ( 9,1m),

- Diameter of Drill Stem
- Threaded
- Welded (optional)

FF < 100' ( 30 m ) <sup>6"</sup> API,

FF < 145' (45 m) <sup>7</sup>" API

## D > 30' (9,1m),

- Diameter of Drill Stem
- Threaded
- Welded (optional)

FF < 145' (45 m) <sup>8"</sup> API RUHRPUMPEN











RUHRPUMPEN Specialist for Pump Technology



29



- Standard tools
  - high hydrodynamic efficiency
- Combination tools
  - optimised hydrodynamic efficiency
  - automatic switching while the pump is in bypass
  - manual switching override





## **RUHRPOMPEN - Combination Tool**



#### **Basic design**

- Slim tool, OD 13"
- Low lift force
- Low torque

#### Switching devices

- Manual / Automated
- At the top of the tool

#### Valves

- Separate valve plates
- No seals, pressure operated

#### • Nozzles, cutting

- 0°
- 10° up both cutting nozzles

#### Nozzles, drilling

- 1 strong centre nozzle
- 3 periphery nozzles

#### Maintenance

 Cartridge/Nozzle removable with Tool in place at drill stem







## Automatic Cutting Tool



#### Tool

Performance test Full test with Jet Pump

#### **Functional test:** Unlimited switch cycles Standard 50 cycles

Auto test tool test bed







## et Pump with Tool



#### Jet Pump

Performance test Full test acc. API 610 (RP-test field) Full speed

#### Functional test: Jet Pump -Motor -Lube oil system -Decoking Control valve -Cutting Tool

Example: Capacity 272 m³/h Head 2850 m

Speed2900 rpmTemperature70 °CMediumWater







## **Control system**



#### Local Operator panel Operator deck

- Operation of
  - Decoking valve
  - Isolation valve
  - Hoist
  - Drill stem drive
  - Interactive P&ID



## RUHRPUMPEN



RUHRPUMPEN Specialist for Pump Technology



35

## RUHRPUMPEN

RUHRPUMPEN				DRI	JM A				Cegelec
User: sssssssss	SSSSSSSSS	II + ABCDE F	GHIJK LMNOPO	RSTUV WXYZ ABCI	DE FGHIJK LMNO	PQ RSTUV WXY	Z 10:41:10	AM Friday, Octo	ber 30, 2009
		Position Inf	ormation		We	ight of Drill			
Absolute	77 4004	NNN.NN	m NNN.NN n	n NNN.NN m		XT-4621			
Relative	21-4621	NNN.NN	m NNN.NN n	NNN.NN m	PINI				
			Abs. Setpoint	Switch Latch	ed				
High Pos. Derrick		ZSH-4621	NNN.NN m						
Park Position		XS-4621	NNN.NN m						
Tool above Top va	alve	XS-4622	NNN.NN m				Drill Orientation		
High High Pos. In	Drum ZS	HH-4621/-4622	NNN.NN m				CW		
Dome Cleaning M	ax Pos.	XS-4623	NNN.NN m		·····		Deill Second		
High Working Pos	s. In Drum	ZSH-4622	NNN.NN m				NNNNN ram		
Tool	l inside Dr	um							
Low Working Pos	s. In Drum	ZSL-4622	NNN.NN m			G740 ∎	Slack rope		
Low Low Pos. In I	Drum ZS	LL4621/4622	NNN.NN m	•••			XS-4624		
	LZ-002A Drum R-001A Drum Status DECOKING LZ-003A								
Overview	Main Pump	A Lube Oil Un	it A Main Pum	p B Lube Oil Unit B	VFD HOIST		I/O Status	Alarm	Alarm Hist
Help	Drum A	Drum B	Drum C	Drum D	VFD Drill Stem		Setpoints	Service	ACK







#### **Ruhrpumpen Free Fall Arrestor System**

#### **Current Standard**

- FFA load tests at institute at load of 9.075 kg, 20,000 lbs
  - Design load of FFA system 11.000kg, 24,270 lbs
- Tests of Crosshead with FFA system in shop with operational load
- Functional test at site

#### **Extended Service**

- Inspection of CH with FFA system at site
- Free Fall Test at site
  - Recommended all 2-5 years
  - Test of Free Fall function at site

#### patented

- Ruhrpumpen Certificate

RUHRPUMPEN Specialist for Pump Technology





37



## FFA - Field Test System



#### **Free Fall Arrestor Test System**

patent pending

#### **Ruhrpumpen Service**

- Test and inspection of CH with FFA system at site
  - Frequent inspection and tests
    - Recommended all 2-5 years
  - Test of Free Fall function at site
  - Ruhrpumpen Certificate







## THANKS FOR YOUR

## ATTENTION

Dr. Wolfgang Paul Paul\_Dr@ruhrpumpen.de RUHRPUMPEN GmbH

RUHRPUMPEN Specialist for Pump Technology



39

