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BTRS-JR[®]



**Autoclave
Engineers** 

Division of Snap-tite, Inc.

General Information

The BTRS-Jr[®] is a complete reaction system for vapor phase catalyst evaluation and continuous flow process analysis. The unit is comprised of three major sections, the feed section, the heated process sections, and the control module. The majority of the process components are housed within an oven enclosure that is maintained at an isothermal temperature.

System Ratings

Operating Pressure: Atm, 30 bar, 100 bar, 200 bar (Atm, 435 psi, 1450 psi, 2900 psi)
Reactor Temperature: 75°C to 1000°C (167°F to 1832°F)
Oven Temperature: 250°C (482°F)

Dimensions

Cabinet: 117 cm (46") wide x 84 cm (42") tall x 36 cm (14") deep.
Heated Oven: 31 cm (12") wide x 61 cm (24") tall x 21 cm (8") deep.

Power: 215 to 245 VAC, 50/60 Hz, 20 Amp, Single Phase

Wetted Materials: 300 Series Stainless Steel, Teflon[®] (PTFE), Kel-F[®] (PCTFE), Kalrez[®], Nitronic[®] 60, Vespel[®] (Polyimide), Nickel alloy A-286, Incoloy-800HT, HR-160, and Quartz.

Bulkheads: Compression fittings for stainless steel tubing with nominal 3.18 mm (0.125") OD x 1.6 mm (0.0625") ID.

Filter Size: 7 micron.

Metering Valves: 18 turn, 1.19 mm (0.047") orifice, 1" stem, 0.010 CV micro metering handle.

Ball Valves: 3-way, 180° actuation for directional flow switching and shut-off.

Check Valves: O-ring seal design, 1.4 bar (20 psi) cracking pressure.

Thermocouples: Type-K (Nickel-Chromium & Nickel-Aluminum).

Tubing: 3.18 mm (0.125") OD x 1.6 mm (0.0625") ID 316 Stainless Steel Seamless tubing.

Notes:

Kel-F[®] is a registered trade name of 3M Company. In 1996, 3M discontinued manufacturing of Kel-F & today, all PCTFE resin is manufactured by Daikin under the trade name of Neoflon[®] or by Allied Signal under the trade name of Aclon[®]. Kel-F is still the most commonly used trade name used to describe PCTFE. Teflon[®] and Vespel[®] are registered trademarks of Dupont Co., Wilmington DE. Kalrez[®] is a registered trademark of Dupont Dow Elastomer, Wilmington DE. Nitronic[®] is a registered trademark of AK Steel Corporation, Middletown OH produced under license by Electralloy Div. of G.O. Carlson Inc., Oil City PA.

Autoclave Engineers, A Division of Snap-tite, Inc reserves the right to substitute an equivalent material for trademarked material. Autoclave Engineers purchases substitute materials based on specification conformance, typically a widely accepted specification created by an industry standards organization.

The customer is responsible to confirm the compatibility of process fluids (at operating temperatures) with the wetted components of the reactor.

Operating Pressure Ranges and Component Ratings

Maximum Operating Pressure	Gauge Range/ Transducer Rating	Maximum Allowable Working Pressure	Rupture Disk Rating
435 psi (30 bar)	600 psi (42 bar) / 500 psi (35 bar)	500 psi @ 1,202°F (35 bar @ 650°C)	35 bar (500 psi)*
1,450 psi (100 bar)	2,000 psi (138 bar) / 2,000 psi (138 bar)	1,600 psi @ 1,202°F (110 bar @ 650°C)	110 bar (1,600 psi)*
2,900 psi (200 bar)	5,000 psi (345 bar) / 3,000 psi (207 bar)	3,200 psi @ 1,202°F (220 bar @ 650°C)	216 bar (3,144 psi)**

*The listed rupture disk rating is nominal. The specification range is +6% and -3%.

** The listed rupture disk rating is nominal. The specification range is +1.5% and -0.75%.

Feed Components

Input streams are provided for four (4) reactant feeds, the reactor purge, and the GC carrier.

Reactant Feeds: Four reactant feed lines consisting of a bulkhead, inline filter, manual metering valve, manual 3-way diverter valve, and a reverse flow check valve. Each of these feeds may be used for liquid reactant.

Heated Oven Components

The heated oven contains the mixing, feed stream routing components, reactor, effluent stream routing components, and pressure control components for the system.

Mixer/Vaporizer: (*Optional*) The unit facilitates the preheating and mixing of the feeds into a homogeneous blend.

Reactor Status Valve: (*Optional*) Multi-port switching valve with 1/8" tube connections, 8-ports, 2-positions, air operator, and manual control. The reactor status valve controls the diverting of either the feed stream or the reactor purge gas through the reactor. When the feed stream is not routed through the reactor, it is routed to the effluent handling section where it can subsequently be sent to the GC. Includes reactor purge gas feed consisting of a bulkhead, inline filter, manual-metering valve, manual 3-way diverter valve, and a reverse flow check valve. The seat options for the valve are either Polyimide seat rated @ 250°C (482°F), or a Peek seat rated @ 200°C (392°F). The maximum pressure for the valve is 100 bar (1450 psi).

Notes:

1. The optional "reactor status valve" is not available on units greater than 100 bar (1,450 psi) models.
2. The Reactor Status Valve option includes a Reactor Purge circuit with inert gas.

Sample Valve: (*Optional*) Multi-port switching valve with 1/8" tube connections, 8-ports, 2-positions, air operator, and manual control. The valve controls the diverting of a measured vapor phase effluent slug of either the feed stream or the reactor effluent to the GC. The seat options for the valve are either Polyimide seat rated @ 250°C (482°F), or a Peek seat rated @ @ 200°C (392°F).

(*Optional*) An isolation valve in series with a metering valve providing a slip-stream sample to the analytical equipment when the isolation valve is cycled open. This arrangement is located outside of the oven.

Notes:

1. If the optional Reactor Status Valve is used then the sample slip-stream will either be that of the reactor effluent or the feed stream depending on the state of the Reactor Status Valve.

2. The polyimide used in the multi-port valves has good resistance to most hydrocarbons and chemicals at 250°C (482°F). Polyimide has limited resistance to primary amines, ammonia and live steam. Contact the factory to discuss materials and process alternatives for solving compatibility problems

Tubular Reactor: The tubular reactor includes inlet filter, outlet filter and full-length internal thermowell. One reactor can be utilized in the sizes given in the table below.

Tubular Reactor

P/N	Wetted Material	Volume	Rating	Inside Diameter	Outside Diameter	Heated Length
301B-2101	316 Stainless Steel	5 ml	2900 psi @ 1200°F 200 bar @ 650°C	0.31" (7.9 mm)	0.56" (14.3 mm)	6.0" (152.4 mm)
301B-2102		10 ml	2900 psi @ 1200°F 200 bar @ 650°C	0.31" (7.9 mm)	0.56" (14.3 mm)	12.0" (304.8 mm)
301B-2103		20 ml	2000 psi @ 1200°F 138 bar @ 650°C	0.52" (13.1 mm)	0.75" (19.1 mm)	6.0" (152.4 mm)
301B-2104		40 ml	2000 psi @ 1200°F 138 bar @ 650°C	0.52" (13.1 mm)	0.75" (19.1 mm)	12.0" (304.8 mm)
301B-2105		100 ml	3200 psi @ 1200°F 220 bar @ 650°C	1.0" (25 mm)	2.13" (54.1 mm)	8.0" (203.2 mm)
301B-2106		200 ml	3200 psi @ 1200°F 220 bar @ 650°C	1.0" (25 mm)	2.13" (54.1 mm)	16.0" (406.4 mm)
301B-2246		A-286	20 ml	2900 psi @ 1200°F 200 bar @ 650°C	0.52" (13.1 mm)	0.75" (19.1 mm)
301B-2247	40 ml		2900 psi @ 1200°F 200 bar @ 650°C	0.52" (13.1 mm)	0.75" (19.1 mm)	12.0" (304.8 mm)
301B-2248	Incoloy 800HT	5 ml	725 psi @ 1652°F 50 bar @ 900°C	0.31" (7.9 mm)	0.56" (14.3 mm)	6.0" (152.4 mm)
301B-2249		10 ml	725 psi @ 1652°F 50 bar @ 900°C	0.31" (7.9 mm)	0.56" (14.3 mm)	12.0" (304.8 mm)
301B-2250		20 ml	725 psi @ 1652°F 50 bar @ 900°C	0.52" (13.1 mm)	0.75" (19.1 mm)	6.0" (152.4 mm)
301B-2251		40 ml	725 psi @ 1652°F 50 bar @ 900°C	0.52" (13.1 mm)	0.75" (19.1 mm)	12.0" (304.8 mm)
301B-2252		100 ml	C/F	1.0" (25 mm)	2.13" (54.1 mm)	8.0" (203.2 mm)
301B-2253		200 ml	C/F	1.0" (25 mm)	2.13" (54.1 mm)	16.0" (406.4 mm)
301B-2254		HR-160	5 ml	90 psi @ 1000°F 6.2 bar @ 1832°C	0.31" (7.9 mm)	0.56" (14.3 mm)
301B-2255	10 ml		90 psi @ 1000°F 6.2 bar @ 1832°C	0.31" (7.9 mm)	0.56" (14.3 mm)	12.0" (304.8 mm)
301B-2256	20 ml		90 psi @ 1000°F 6.2 bar @ 1832°C	0.52" (13.1 mm)	0.75" (19.1 mm)	6.0" (152.4 mm)
301B-2257	40 ml		90 psi @ 1000°F 6.2 bar @ 1832°C	0.52" (13.1 mm)	0.75" (19.1 mm)	12.0" (304.8 mm)
301B-2258	100 ml		C/F	1.0" (25 mm)	2.13" (54.1 mm)	8.0" (203.2 mm)
301B-2259	200 ml		C/F	1.0" (25 mm)	2.13" (54.1 mm)	16.0" (406.4 mm)
301B-2260	Quartz		5 ml	Atm @ 1832°F 0 bar @ 1000°C	0.24" (6.1 mm)	0.38" (9.65 mm)
301B-2261		10 ml	Atm @ 1832°F 0 bar @ 1000°C	0.24" (6.1 mm)	0.38" (9.65 mm)	12.0" (304.8 mm)

The standard end fitting of the tubular reactor is equipped with an unused (plugged) connection. It can be used to feed liquids (trickle feed) directly to the reactor through a dedicated line that bypasses the mixer/vaporizer assembly.

The reactor tubing configuration creates downward flow, i.e. in the top and out the bottom unless otherwise specified. Pre-bent tubing to produce reverse reactor flow (upward) is included as loose parts with the system.

Pressure Gauge: Isolator - 316 SS, silicon fluid filled (located in heated oven).

Gauge - 63.5mm (2-1/2") diameter face, dual scale psi...bar (located on front panel).

(Optional) Transducer - Accuracy of +/- 0.13% of full scale at constant temperature.

Back Pressure Regulator: Provides manual control for system pressure. The pressure portion is located in oven.

(Optional) Electronic back pressure regulator used to provide automated closed-loop control of system pressure. The pressure portion is located in oven. The electronic back pressure regulator is not bubble tight.

Gas/Liquid Separator: *(Optional)* The gas/liquid separator is located on the outlet of the reactor before the back pressure regulator outside of the oven. Level control of the liquid hold-up is accomplished via a manual metering valve and a manual ball valve, or optional automatic control for draining to a collection tank. The volume of the separator vessel is 150 ml.

Separator Options:

- Ambient with no temperature control provided.
- Circulator Ready with a 1/4" copper tubing wrapped around the outside of the separator with bulkheads provided for connection to a Heater/Chiller unit.
- Electric heater for temperature control up to 204°C (400°F)

Heated Transfer Line: *(Optional)* The heated transfer line connects the sample valve to a GC. It ensures a complete sample arrives at the GC by delivering it at elevated temperature to prevent any condensation. Optional heated transfer lines can be used to connect between components outside of the oven and maintain higher temperature operation.

Length: 1.83 m (6 feet)

Inside Diameter: 0.027" (0.69 mm)

Max Temp: 300°C (572°F)

GC Adapter: Universal needle nut assembly including needles, septa, nut & ferrule.

Control System

The controls for the BTRS-Jr® are based on a series of discrete process controllers which not only control the unit but also monitor critical alarm points that shutdown the unit when necessary. The valves are controlled by discrete push buttons.

Pressure Control: The pressure will be controlled and monitored via the discrete instrumentation. This will be included when the pressure transducer and electronic back pressure regulator options are chosen.

Temperature Control: All heater control loops for the reactor, heated oven, and transfer line are closed loop control with fail safe power interrupting capability. Temperatures are constantly monitored to ensure safe operation.

Alarm Monitoring: Pressure and Temperature process variables are monitored for shut down and set point deviation conditions.

Data Acquisition: *(Optional)* The control instrumentation can be provided with RS-485 communication capability and rudimentary access to the controller variables including the set points and actual process variables. These can be saved in Excel format for detailed data manipulation. This would include reactor temperature, reactor over temp, transfer line temperature, oven temperature, and system pressure.

Mass Flow Controllers: Mass Flow Controllers can be provided in a discrete, stand-alone module for use with the BTRS-Jr[®]. The enclosure includes the control module, mass flow controller, associated tubing components, and bulkheads for inlets and outlets. Up to four mass flow controllers can be housed within the module. The limits for the flow controllers are 200 bar (2900 psi) and 10,000 sccm (610 in³/min).

MFC-1: Gas: _____
 Pressure: _____ bar
 Flow rate: _____ sccm

MFC-2: Gas: _____
 Pressure: _____ bar
 Flow rate: _____ sccm

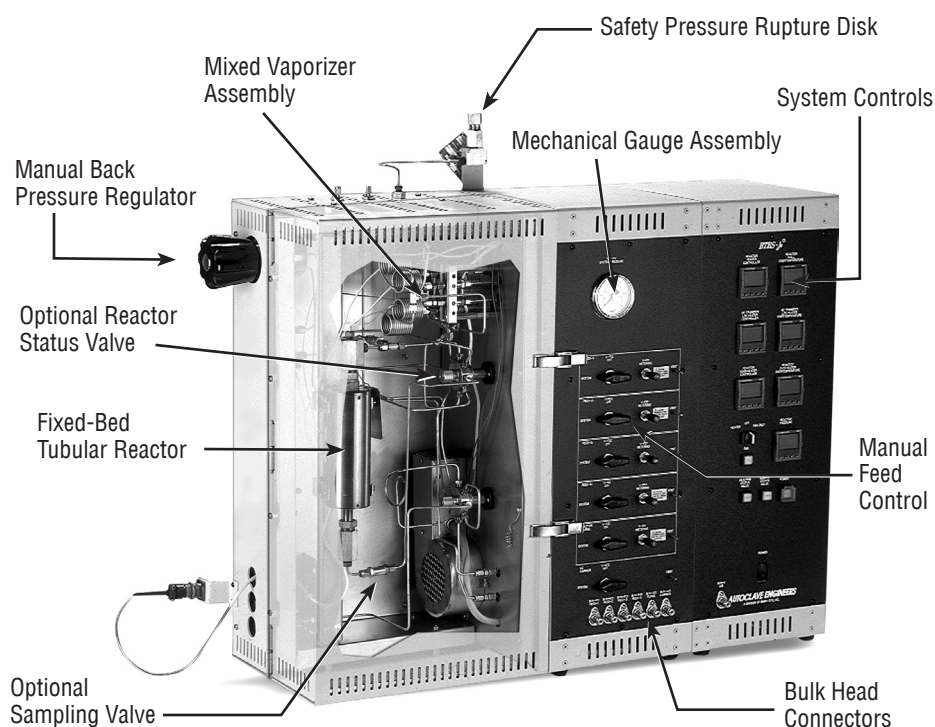
MFC-3: Gas: _____
 Pressure: _____ bar
 Flow rate: _____ sccm

MFC-4: Gas: _____
 Pressure: _____ bar
 Flow rate: _____ sccm

Liquid Pumps: High Pressure Liquid Pumps can be added to the BTRS-Jr[®]. These pumps generate high pressure with accurate flow and are controlled electronically from the front panel of the pump. The pumps have a maximum pressure of 400 bar (5,800 psi) at up to 10 ml/min, 100 bar (1450 psi) at up to 40 ml/min, and 50 bar (725 psi) at up to 80 ml/min.

Pump-1: Gas: _____
 Pressure: _____ bar
 Flow Range: _____ mL/min

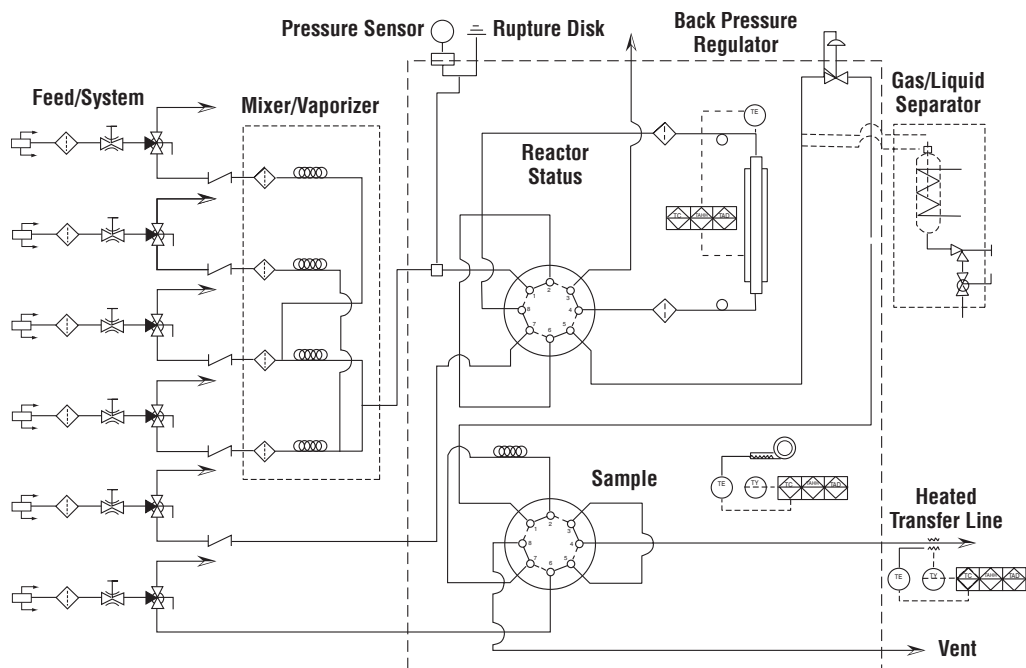
Pump-2: Gas: _____
 Pressure: _____ bar
 Flow Range: _____ mL/min



General Arrangement

Optional Equipment

Flow Schematic



Ordering Guide

BTRS-JR

A B C D E F G H J K L

Part Number Example: **BTRS-JR045005SS01211542** (See chart below)

A - Base BTRS-Jr®		G - Sample Valve	
045	450 psi (30 bar)	0	No
145	1450 psi (100 bar)	1	Slip Stream
290	2900 psi (200 bar)	2	Multi-Port
B - Reactor Size		H - Heated Transfer Line	
005	5 ml	0	No
010	10 ml	1	Yes
020	20 ml		
040	40 ml	J - Gas/Liquid Separator	
100	100 ml	0	Ambient & Manual Drain
200	200 ml	1	Ambient & Timed Drain
C - Reactor Material		2	Circulator Ready & Manual Drain
SS	316 Stainless Steel	3	Circulator Ready & Timed Drain
A2	A-286	4	Heated to 400°F (204°C) & Manual Drain
HT	Incoloy 800 HT	5	Heated to 400°F (204°C) & Timed Drain
HR	HR-160	K - Mass Flow Controllers	
QU	Quartz	0	None
D - Mixer/Vaporizer		1	1 Mass Flow Controller
0	No	2	2 Mass Flow Controller
1	Yes	3	3 Mass Flow Controller
E - Reactor Status Valve		4	4 Mass Flow Controller
0	No	L - Liquid Pumps	
1	Yes	0	None
F - Pressure Monitoring and Control		1	1 Liquid Pump
0	Analog Gage & Manual BPR	2	2 Liquid Pumps
1	Analog Gage w/ Transducer & Manual BPR		
2	Analog Gage w/Transducer & Automatic BPR		



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Bulletin BTRS-JR

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