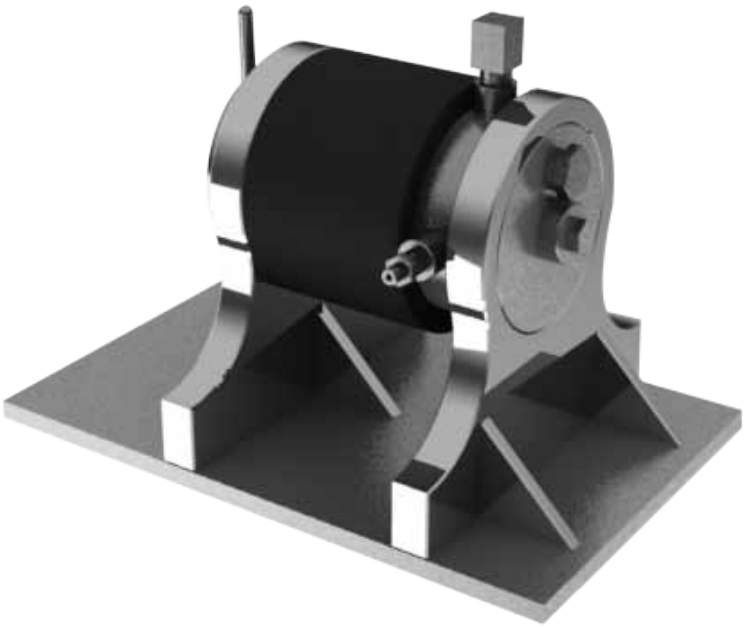
OZM RESEARCH
Instruments & Technologies for Energetic Materials

STOJAN VESSEL SV-2
ADVANCED INSTRUMENT FOR MEASUREMENT OF THE BURNING RATE OF SOLID ROCKET PROPELLANTS IN A CLOSED VESSEL

Product Datasheet



STOJAN VESSEL is an instrument designed for determination of ballistic properties of solid rocket propellants. The measurement using **STOJAN VESSEL** is based on the most modern procedure for determination of burning rate of double base or composite rocket propellants.

Determination of burning rate, i.e. gas pressure dependence $u(p)$, is usually carried out using Crawford bomb (strand burner) or small-scale rocket motors. Both conventional methods are based on measurement of burning time of standardized solid propellant grain at constant or semi-constant pressures. About 10 individual measurements are necessary to determine the burning rate in whole pressure range for both methods. Crawford bomb is expensive and complicated equipment needs precise controlling of constant pressure and burning rate detection. The measurement using small-scale rocket motor is more dangerous due to unpredictable sample burning causing explosion.

In comparison with Crawford bomb, **STOJAN VESSEL** is a simple and safe instrument based on the more advanced mathematical procedure for calculation of ballistic properties taken from only one shot. This procedure was invented and developed by Dr. Peter Stojan about 10 years ago and the measurement using his instrument became the standard method in the Czech Republic.

APPLICATIONS

The main advantage of the **STOJAN VESSEL** is the processing of measured pressure-time curves (see Fig. 1) using unique mathematic procedure based on ballistic equations. This procedure involves evaluation of burning rate vs. pressure dependency in a wide pressure range (see Fig. 2) using experimental data obtained from just **one measurement**. Evaluating the range of pressure is limited by the pressure generated by ignition and the pressure generated by propellant (max. pressure). The experimental results of the **STOJAN VESSEL** are comparable to the experimental values achieved from small-scale rocket motors (see Fig. 3).

The **STOJAN VESSEL** is used for research and development or for production control of double base and composite solid rocket propellants (including high energetic compositions). The influence of the following parameters to ballistic properties of tested propellants are observed.

- influence of different kinds of additives or basic substances (catalysators, moderators, binders, oxidizers, etc.)
- dependence on initial temperature of the propellant
- check of homogeneity or porosity of the sample
- prediction of unstable burning or explosion hazard (e.g. after stability tests)

INSTRUMENT DESCRIPTION

The **STOJAN VESSEL** instrument consists of low pressure closed vessel equipped by two valves, a lid, a pressure transducer, a HV spark gap ignition housing, a grid used as a sample holder, a water cooling jacket and a temperature conditioning unit (Fig. 4 & 5). The measurement and operation is carried out using a control unit connected to the personal computer with software ABSW-2 for data acquisition and evaluation. Results of the measurements can be verified using a testing rocket motor, supplied optionally. The testing laboratory must also be equipped by a small plant for sample preparation and a sample conditioning unit in the temperature range of -60 °C to +70 °C.

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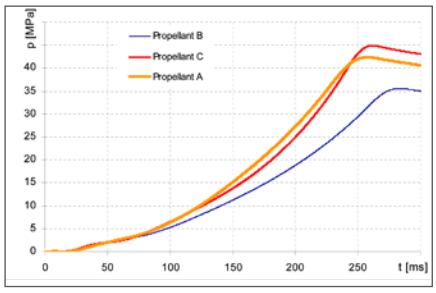


Fig. 1 Pressure *p* - time *t* dependencies measured using STOJAN VESSEL

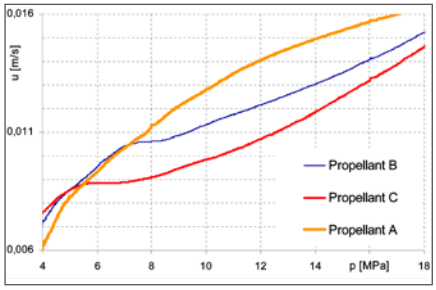


Fig. 2 Burning rate *u* [m/s] - pressure *p* [MPa] dependencies calculated from experimental data measured using STOJAN VESSEL.

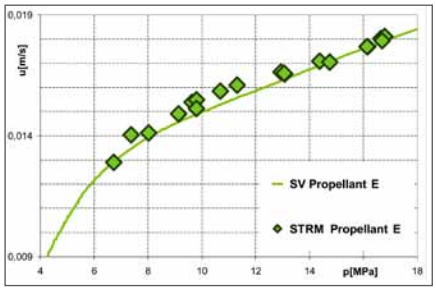


Fig. 3 Comparison of burning rate/pressure curve obtaining by STOJAN VESSEL (line) and by Small-scale Rocket Motor (points).

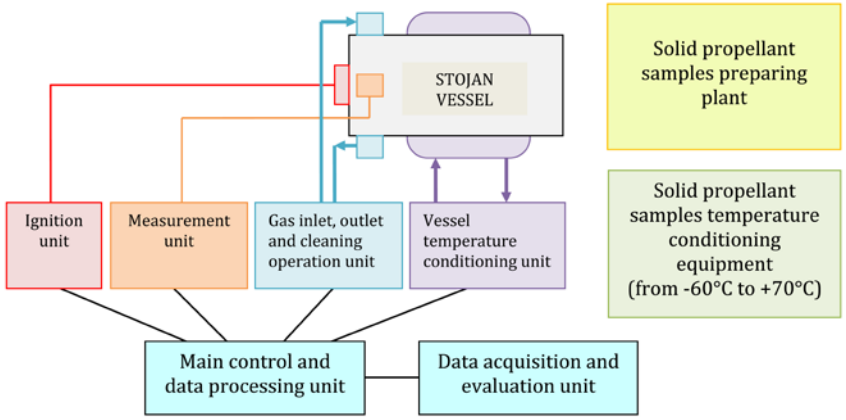
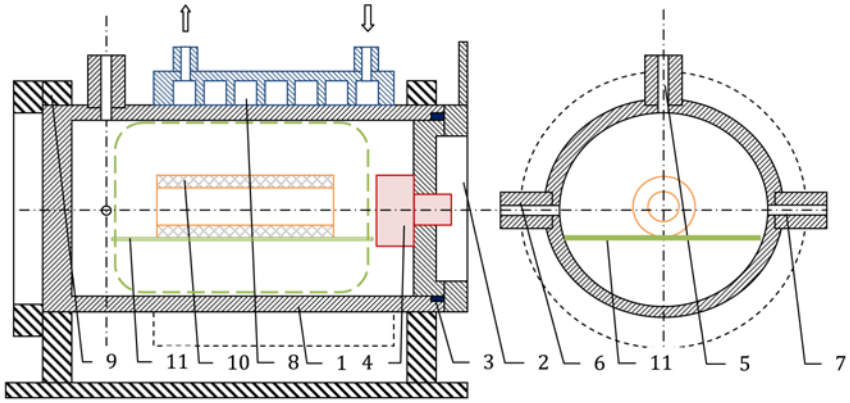


Fig.4 Schematic diagram of STOJAN VESSEL instrumentation



1 – Pressure vessel
2 – Lid
3 – Sealing
4 – HV spark gap ignition housing
5 – Pressure transducer fitting
6 – Gas outlet valve
7 – Gas inlet valve
8 – Water cooling jacket
9 – Vessel support
10 – Propellant sample
11 – Grid (sample holder)

Fig. 5 STOJAN VESSEL instrument cross-section

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STANDARD INSTRUMENT PARTS

SV2-PV	STOJAN vessel - pressure vessel (2 L, 50 MPa), lid with HV plug, breach screw - pressure transducer fitting - gas outlet valve - gas inlet valve - cooling jacket - stand
SV-CU	Control unit - control unit of valves, cleaning and conditioning - high voltage ignition unit - safety switch inputs - PC communication - chiller for cooling jacket - mobile working table - remote control - leading and control cables
SV-MU	Measurement unit - high speed DAQ - PC communication - pressure transducer conditioner - leading and measurement cables - thermometer
SV-PT250	Pressure transducer 0-250 Bar
SV-PT500	Pressure transducer 0-500 Bar
DAEU-17	Automatic control, data acquisition and evaluation unit (notebook with this minimum configuration or higher: 17'' display, 2 GHz processor, 1.8 GB RAM, DVD-RW, HDD 250 GB, WLAN, BT, LAN, USB, Win 7)
SV-ABSW2	Control and Ballistic software ABSW-2 - SW for automatic control of system operation - SW for measurement, calibration and data acquisition - SW for results evaluation
SV-STK	Starting kit for Stojan vessels (for ca 1000 rounds) - cleaning set (bucket, brushes, cleaning cloths, etc) - kit of lubricant and conservant - equipment and tools for assembling - materials for preparation of inhibitors (material, glue, scissors) - grid (sample holder) 20 pcs - HV spark gap ignition housing, 20 pcs (with spare inner parts) - protective for conditioning - plastic bags (hose 10 m), welder - dimensional gauges (vernier caliper, steel ruler) - thermally insulated container for carrying samples
SV-TCI	Tools for cutting of circular inhibitors (diameter 2.6 mm)

SPARE PARTS

SV-EV	Spare gas valve (with drive unit and adapter)
SV-LHSV2	Spare lid with HV plug
SV-IAPT	Spare interchangeable adapter for pressure transducer including sealing
SV-TICC	Thermally insulated container for carrying samples, 2 pcs

CONSUMABLES

SV-SH	Grid (sample holder) 10 pcs
SV-PH10	Protective plastic bags (hose 10 m)
SV-SPFI	Set of materials for preparation of flat inhibitors (for ca 1000 pcs) - base material for inhibitors (2 sqm) - glue
SV-SSV2	Sealing set for SV-2 vessel (lid, valve, cooling jacket, etc)
SV-KLC	Kit of lubricant and conservant for Stojan vessel (pressure transducer lubricant and thread lubricant)
SV-SGSV2	HV spark gap ignition housing, 10 pcs (with spare inner parts, for 500 rounds)

OPTIONAL ACCESSORIES

auxiliary gauges

CS-BHT	Climatic station - measurement unit - barometric pressure - laboratory humidity and temperature
PRCAL50	Pressure calibrator set (range up to 50 MPa, min. accur. 0.05 % FS)
SV-DIMU	Digital multimeter set for service maintanance (min. 600 V, 5 A, 5 MOhm,...)

sample preparation

SV-HPRS	Hydraulic press for sample preparation - remote controlled - min 20 t
SV-PRTD	Pressing tools for disc propellant grain
SV-PRTT	Pressing tools for tubular propellant grain

sample conditioning

EPCC450	Ex-proof test climatic chamber (for an atmosphere causing an explosion = with ATEX (- II 2/- G IIB T4 Gb/-), min. range -60 °C to +90 °C, vol. 450 l)
TTC190	Temperature testing chamber (non-explosion proof, compresed air flush for purifying the test space to prevent from an explosive atmosphere, range -60 °C to +70 °C, vol. 190 l)

instalation accessories

SV-IT	Isolation transformer (230 V, 600 W)
SV-AC6	Air compressor (min 6 bar, 30 l/min)
SV-UPS500	Uninterruptible Power Supply (230 V, min 500 W, 60 min)

others

SSPTB-50	Stainless steel protective testing box - for firing of samples under barometric pressure conditions
CHS-600	Compact high speed camera 600 f/s
BCA 500	Bomb calorimeter BCA-500
TRM-35	Sub-scale rocket motor for tubular propellant grain

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TECHNICAL PARAMETERS

Pressure vessel

Volume:	2000 cm^3
Working pressure:	50 MPa (tested 75 MPa)
Water jacket temperature:	15 - 22 °C
Material of vessel:	stainless steel
Loading density:	< 0.035 kg/dm^3

Data acquisition

Pressure range:	0 – 50 Mpa
Accuracy:	0.5 %
Sampling rate:	100 kHz

Sample

Sample weight:	50 g ± 15 g
Shape of sample:	a) Disc with insulation on circumference, wall 10 mm ± 5 mm, diameter 70 mm ± 20 mm b) Tube with insulation on front surfaces , thickness 10 mm ± 5 mm, diameter 30 mm ± 10 mm, length < 10x (diameter – 2x thickness)
Sample temperature range:	from -60 °C to +70 °C (by means of temperature chambers)

EXPORT LICENSE

Export of STOJAN VESSEL instrument is subject to export license for military goods from the Czech Republic. The apparatus can only be exported after having received the approval of the licensing authority concerned. To apply for the valid export license, international import certificate or end-user certificate is required.

SHIPPING DATA

Package dimensions (W x L x H):	TBD
Package gross weight:	TBD
Custom code:	9031 20 00

INSTALLATION REQUIREMENTS

Space requirements:
W x L x H: min. 120 x 150 x 160 cm;
Net weight: approx. 250 kg

Space requirements (Data acquisition unit):
W x L x H: 41 x 32 x 32 cm;
Net weight: 3.5 kg

Stable electric power source:
230 V / 50 Hz, 2500 W

Tap water source

Fume hood or local exhaust

Source of pressurized air (min. 6 Bar, 100 l/min)

Bunker or fragment impact resistant structure equipped by safety door (21°C +/-5°C, RH 30 - 70%)

The instrument must be placed on a safe place and controlled remotely to protect the operator

Measurement room for operators (21°C +/-5°C, RH 30 - 70 %) max. 5 m away from bunker, with tables, chairs and light

Laboratory for sample preparation (21°C +/-2°C, RH 30 - 70 %)
- with measuring equipments for weight and dimensions measurement of samples and with sample processing capability by cutting, drilling and turning

Laboratory for sample temperature conditioning
- protected room with temperature chambers for required temperature range, max. 10 m away from testing bunker

Measurement of barometric pressure, laboratory humidity and temperature

Pressure calibration (source and measurement, range 5 - 50 MPa, min. accur. 0.05 % FS)

Digital multimeter set for service maintanance (min. 600 V, 5 A, 5 MOhm, etc.)

Two operators trained in basic ballistics with knowledge of on-site laws

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