Rupture Disc to enhance safety and reduce plant emissions

- EPSC 4th European Conference
- Barcelona 3rd of December 2024

Industrial Safety Systems

Rupture Disks

Discos de Ruptura

Name Rick King, Jordi Rovira

Date December 2024

Rick King

ZOOK Director - Global Application Engineering

Rick has over 23 years of his 63 total in the rupture disk industry with a pipework and fabrication background previous to joining ZOOK

Rick's history with ZOOK has been in Engineered Sales via Quality and Operations Management before becoming Director for Sales EMEA in 2019

In 2023 Rick took up his role as director of a new department focusing on Application Engineering to support our client base to ensure rupture disk product is understood and applied safely by users at all levels

Outside ZOOK Rick is a participant and leader of several working groups for the API 520 Sub Committee for Pressure Relief Systems

'More Good Installations'

Why Use Rupture Disks

Save human lives, capital plant and the environment

Instantaneous full flow pressure relief

Maintenance free – no moving parts

Protect Pressure Relief Valve against corrosion, plugging and leakage

Low-Cost, **Leak Free Device**

Exotic material benefits at a fractional cost– i.e., Tantalum, Hastelloy

I will talk some more on these topics then Jordi Rovira of AURA Industrial Safety Systems will talk about why ‘instantaneous’ is important

Who cares?

Your people, toxic emissions are dangerous. Environmental agencies.

VP of Finance, leaks cost money - lost product, damaged plant, fines.

Multiple Standards EN13160, EN378, LDAR &&&

Leak free?

Nothing is leak free, a rupture disk can come close

Low-Cost, **Leak Free Device**

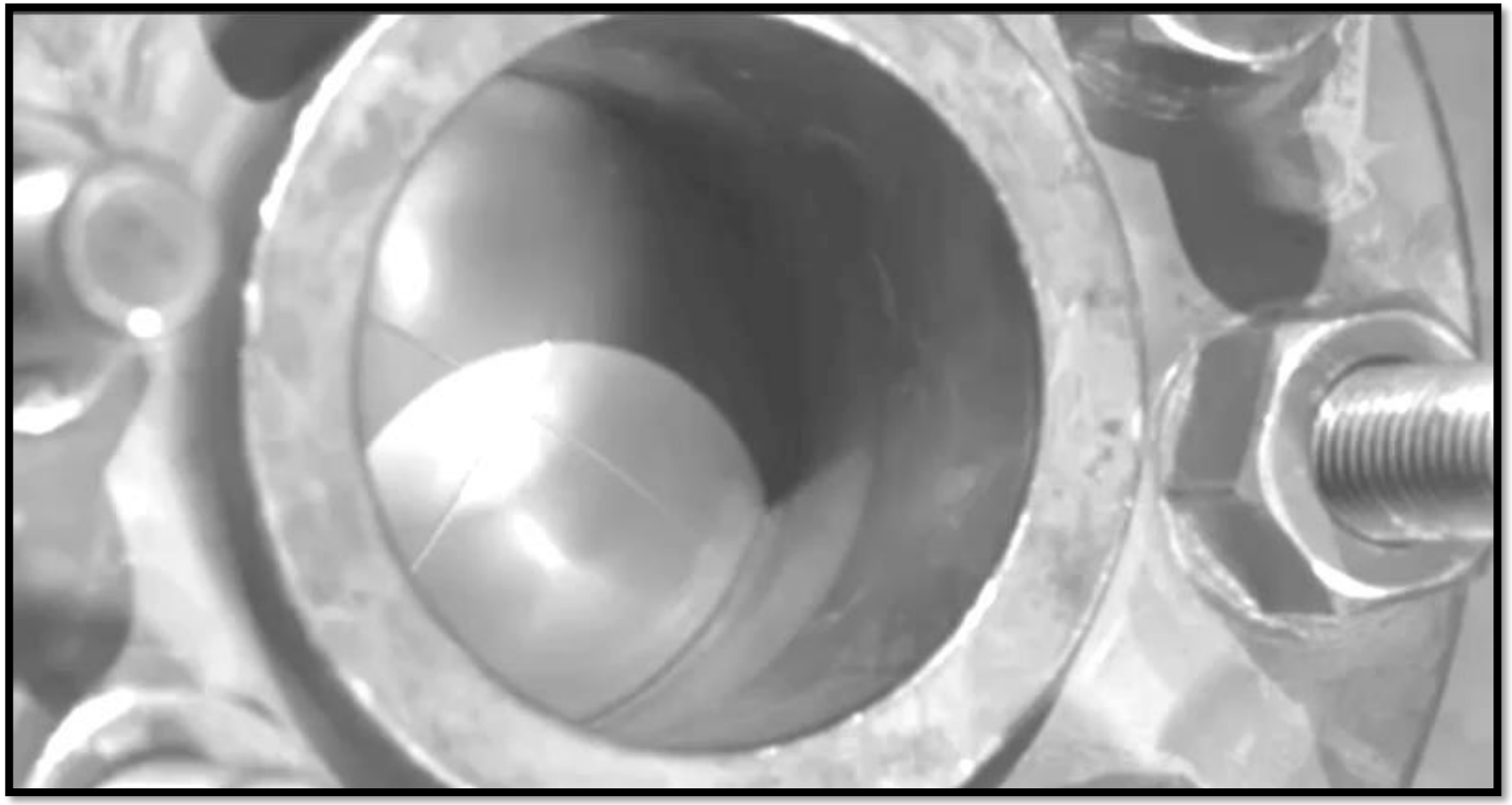
We have a solid metal membrane barrier

Permanently assembled metal to metal seal

Leak rates 1 x 10^{-6} mbar.l.sec^{-1} He and better

Next level? Welded assemblies.

Instantaneous Full Flow Pressure Relief, Leak Free Device



DN 50

Scored forward acting disk

Opening time ~2ms

Instantaneous Full Flow Pressure Relief, Leak Free Device

DN 50 reverse acting disk

First replay slowed 1800 times

Second replay slowed 5500 times

Opening time ~2ms

No change of direction

About Us

Industrial Safety Systems

AURA

AURA Industrial Safety Systems

Established in October 2018
Specialized in Pressure Relieve and Explosion Protection

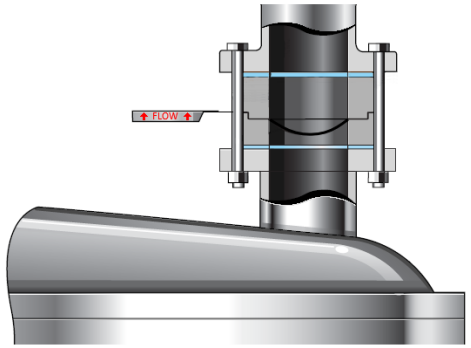
- ZOOK's Distributor for Rupture Discs
- Pressure and Vacuum Relief Valves
- Flame Arresters
- Supplier of Explosion Vent Panels and Flameless Venting.
- Sizing rupture disks for gas, steam, liquids, supercritical and two-phase flow using main standards, numerical integration and W-Method.
- Sizing Explosion vents for gas and dust clouds using EN14994 EN14491 and NFPA68

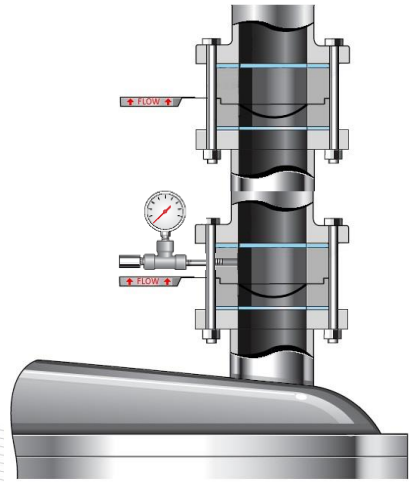
Jordi Rovira Pascual

Bachelor in Physics by la Universitat de Barcelona
Advanced Emergency Relief System Design, DIERS Method
18+ years of experience in pressure Relieve and Explosion protection.

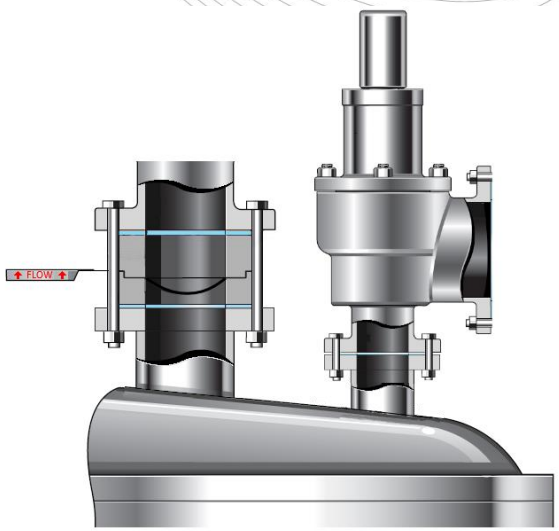
1. Rupture Disc as part of the ERS

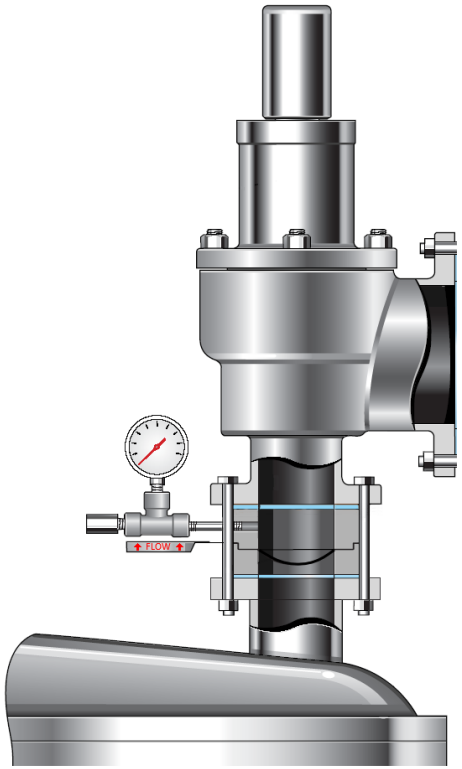
Primary relief





RD In combination with SRV





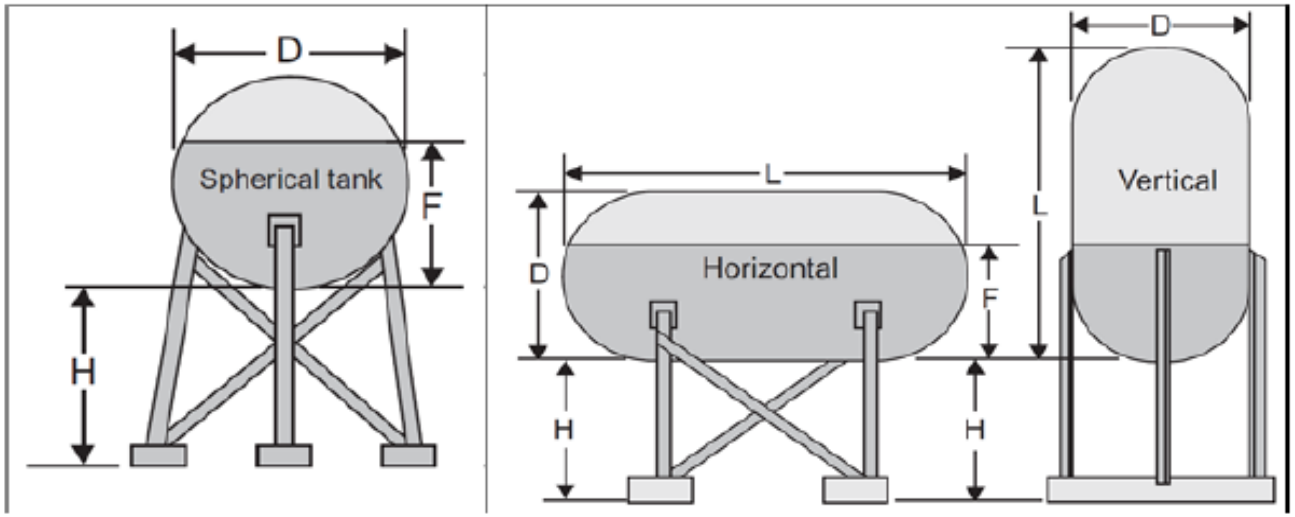
2. Sizing EN4126-7 & API520

Minimum relief área for the required Q_m flow capacity			
Fluid		Formula	Constantans values
Gas Vapor	Critical	$A_0 = \frac{Q_m}{C\alpha P_0}\sqrt{\frac{Z_0 T_0}{M}}$	$C = 3.948\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$
	Subcritical $K_b = \frac{F}{C}$	$A_0 = \frac{Q_m}{K_b C\alpha P_0}\sqrt{\frac{Z_0 T_0}{M}}$	$F = 3.948\sqrt{\left(\frac{2k}{k-1}\right)\left[\left(\frac{P_b}{P_0}\right)^{\frac{2}{k}} - \left(\frac{P_b}{P_0}\right)^{\frac{k+1}{k}}\right]}$
Liquids	$A_0 = 0.621\frac{Q_m}{K_v\alpha\sqrt{\rho(P_0 - P_b)}}$ Kv=1		For fluids with viscosity : $R_e = 0.3134\frac{Q_m}{\mu\sqrt{A_0'}}$ $K_v = \left(0.9935 + \frac{2.878}{Re^{0.5}} + \frac{342.75}{Re^{1.5}}\right)^{-1}$

Sizing for emergency venting

DN150,
could you please check it?

Producto Alcohol Etílico	Calor Latente vaporización J/kg	Punto ebullición ºC	Peso Molecular Kg/Kmol	Superficie mojada [m^2]	Calor absorbido por exposición al fuego (W)	N m^3/h de Aire requerido
(F15) API2000 - EN28300	846000	78.3	46	51	2076027	6149
Tabla 7 API2000 - EN28300	N.A.				N.A.	10005



Forma del tanque:	Vertical	Tag:	Tanque tipo 1 - 8m conducto descarga

Cálculo de la superficie mojada			PS =	0.2	bar-g; ≤ 1,034 bar-g
Diámetro D	3.55	m	F =	1	Ver tabla "Enviromental Factor"
Altura H	1.0	m			
Longitud L	2.80	m			
F (Altura tanque < 9.14m)	2.80	m			

Superficie mojada Efectiva	51.02 m^2	Vol. Total	28 m^3

Ruego nos oferten su mejor precio y plazo para:

TIPO 1

- Cantidad: 1 unidad
- Capacidad: 28,1 m^3
- Diámetro: 3,4 m
- Altura envolvente: 2,75 m
- Techo: Cónico 15º
- Fondo: Cónico 20º
- Producto: Alcohol etílico 96.7%
- Presión de diseño del tanque: 200/-8 mbarg
- Presión de trabajo: Atmosférica
- Temperatura de diseño: 40ºC
- Temperatura de trabajo: 20ºC
- Caudal de llenado: 25 m^3/h
- Caudal de vaciado: 25 m^3/h
- Material depósito: Inox-304

Tamaño disco de ruptura: DN-150 (solicitado por cliente) comprobar y dimensionar según cálculos

… disc installed at the end of an 8 m long pipe outside the warehouse…

Relieving conditions

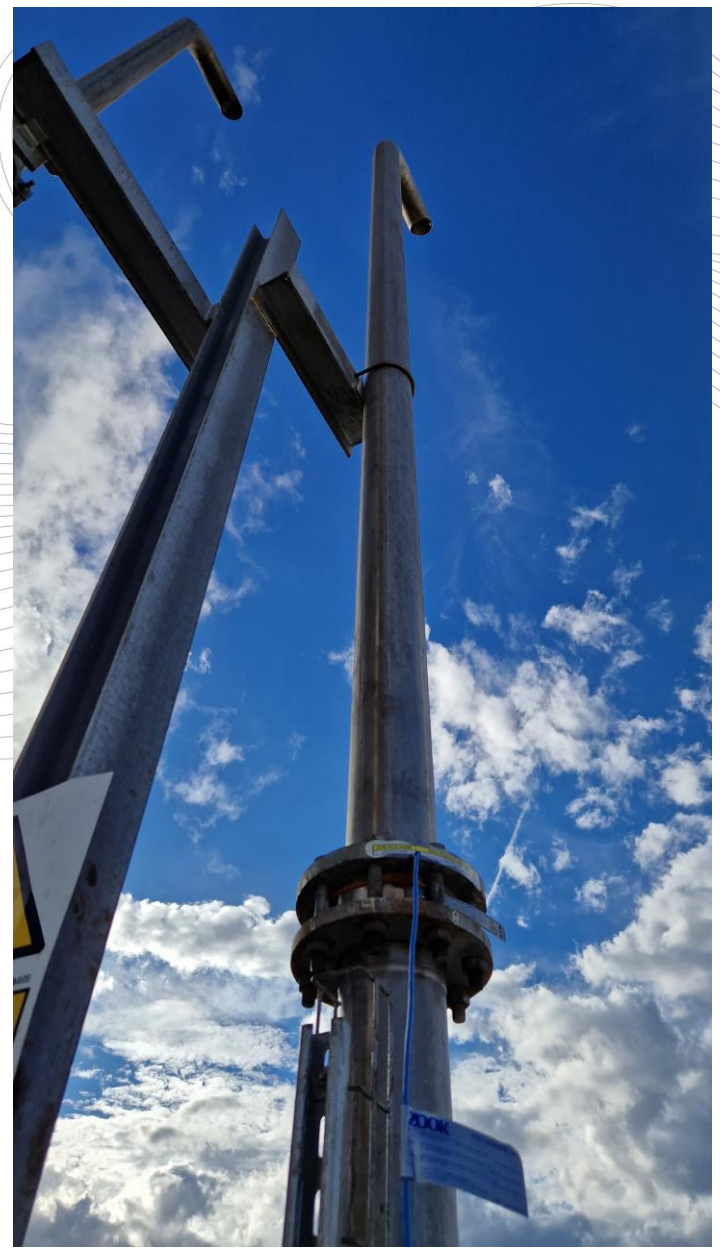
Temperature of fluid	t0	*78.0*	°C
Relieving pressure	p0	*150.0*	mbar(g)
Back pressure	pu	*0.0*	mbar(g)

Properties at relieving conditions

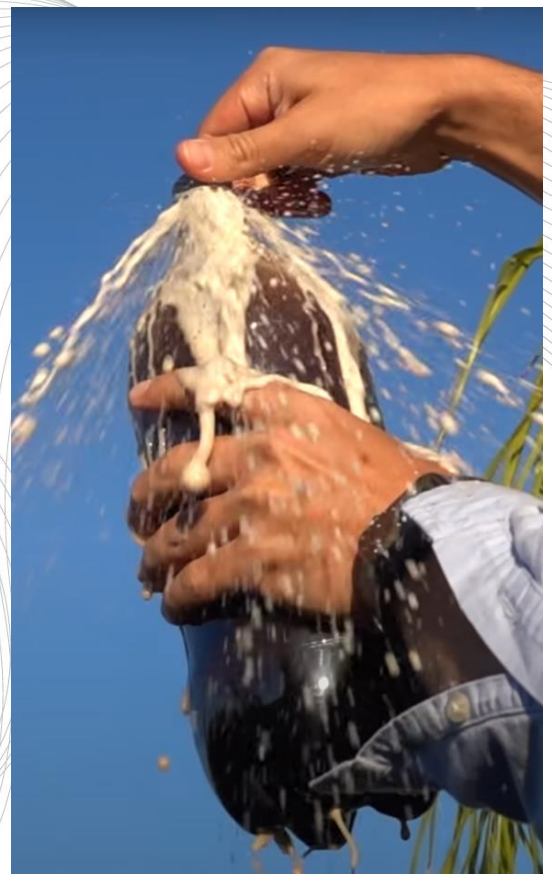
Density of fluid	ϱ	*1.154*	kg/m³
Isentropic exponent	ϰ	*1.3995*	-

Sizing

◉ Mass flow rate	qm	*7,952.0*	kg/h
○ Volume flow rate (standard conditions)	qn	*6,149.7*	m³/h
☒ Use flow resistance method			
Flow resistance of the rupture disc	KrG	*2.4*	-
Zeta value of all installations	ζ	*1.26*	-
1 Elbow 90°, Rough Angle = 90° (1.26)			
Pipeline length	l	*8.0*	m
Pipe roughness	k	*0.03*	mm
Required inside diameter	Di,min	*192.21*	mm
Required pipe cross-section	A,min	*29,016.0*	mm²
◉ Size and pressure class		*EN (metric)*	
Size class	DN	*DN 200*	
Pressure class	PN	*PN 10*	



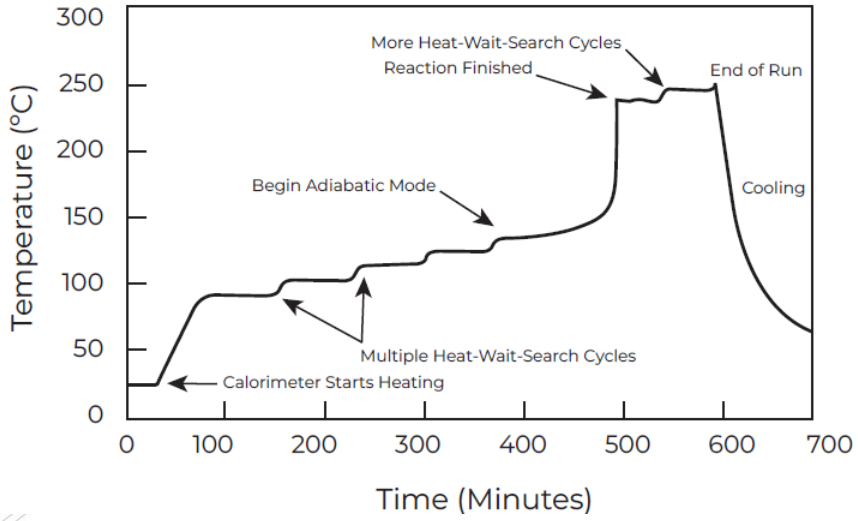
3. Two phase flow, DIERS method

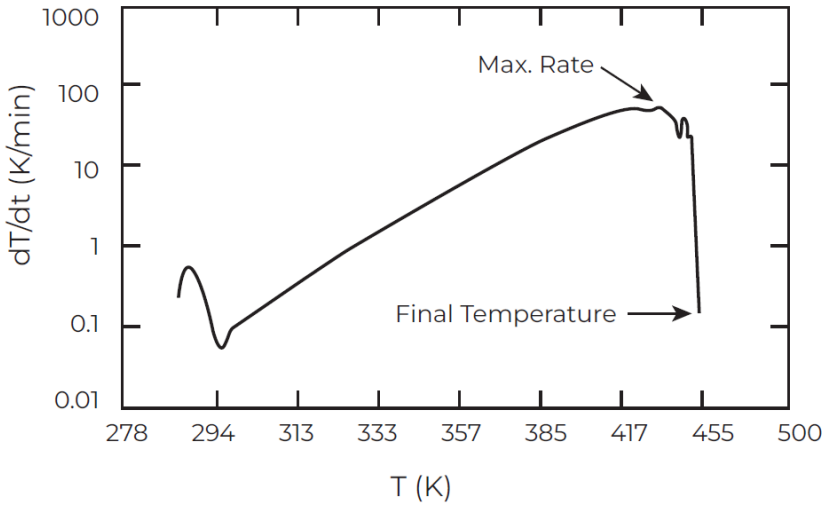


4.1 Runaway, a) Knowing the reaction

Small scale reaction reproduction.

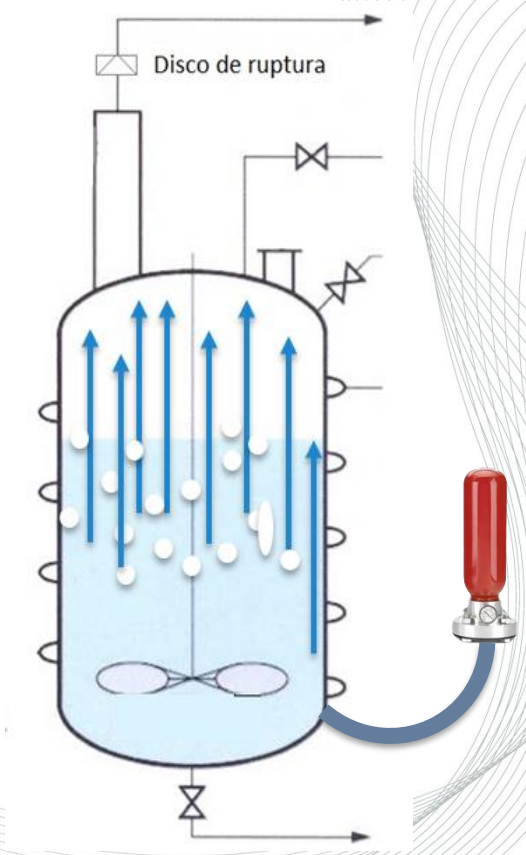
- At with T starts, Non retorn temperature, ERD reaction time < $PS/(dP/dt)$, $\left[\frac{dP}{dt}\right]_{max}$ $\left[\frac{dT}{dt}\right]_{max}$
- Secondary decomposition.
- By products



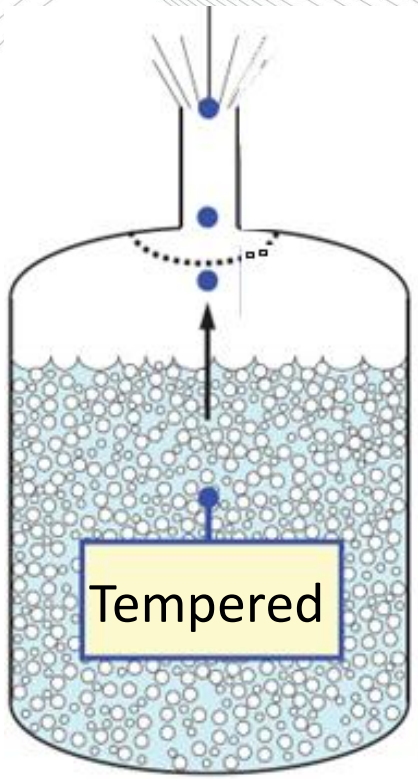


4.2- Prevention and protection against a runaway

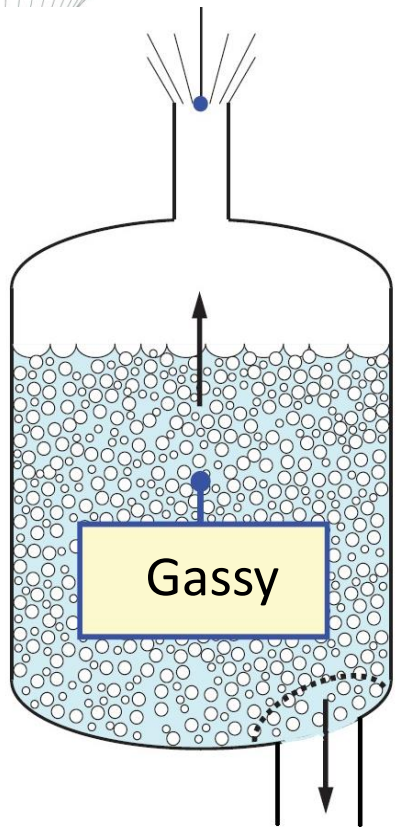
Prevent the reaction



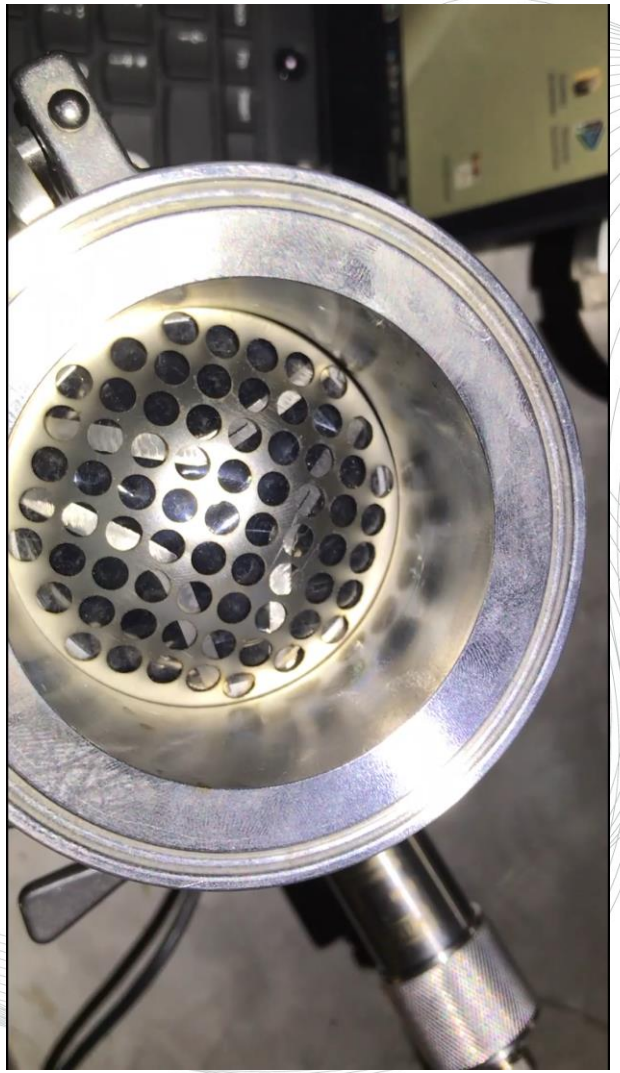
Venting on top



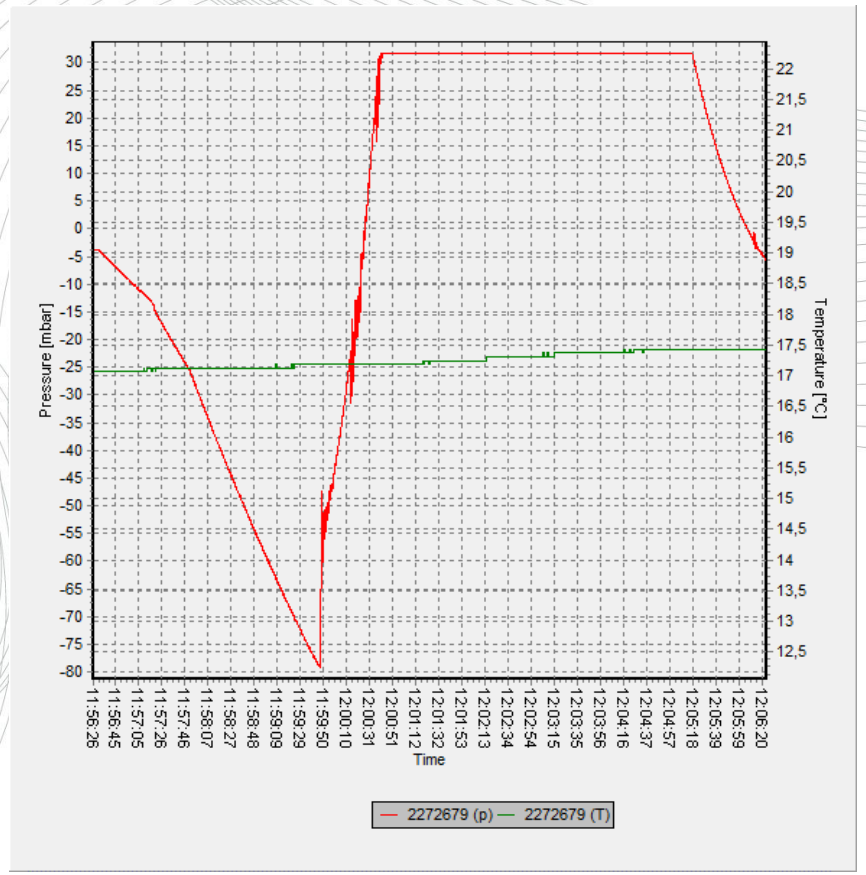
Venting on the bottom

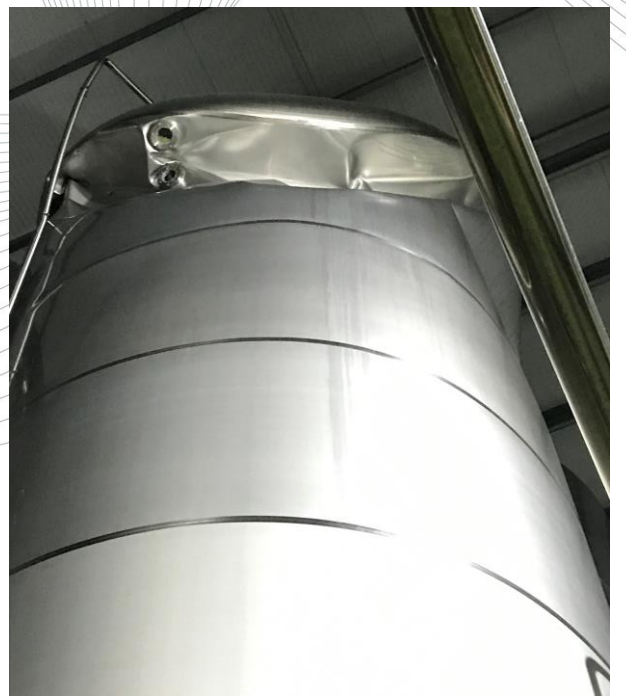


5. Applications. 1.-Vacuum protection



Taks for food Industry.
Burst pressure: 2.5-17 mbarg





5.3 SWRO desalination. Low & high pressure

	Proyecto	EPC	m3/dia	Personas
E, SI &R	Guaymas	Aqualia	17280	105000
E, SI &R	Taweelah	ABENGOA	909200	1600000
R	Jubail 3A	ABENGOA	600000	1600000
E, SI &R	Hamriyah	TR - PPA	76000	Industrial
SI & R	Atacama	GS Inima	38880	210000
E, SI &R	Jubail 3B	Acciona	570000	2000000
E, SI &R	Shuqaiq3	Acciona	450000	300000
R	Oropesa	Acciona	48750	300000
R	Torrevieja	Acciona	240000	440000
R	Campodalias	Veolia	97200	300000
SI & R	Rabigh 4	IWAC / Wetico	600000	1200000
		TOTAL:	3,647,310	8,055,000

5.4 Normal and emergency venting inerted reactor.

5.5 Aerospace

Fuel tanks for rocket

Conversion of airplanes to tankers

Satellite Cooling circuit

5.6 Runaway lithium batteries

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Muchas Gracias

Merci Beaucoup

Dankeschön

Grazie Mille

Dankuwel

Tak

Thank you