

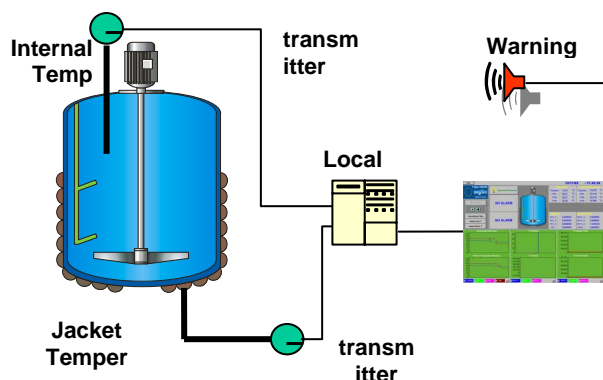
## On-line warning detection system of runaway initiation using chaos theory techniques

### Description

The present invention concerns the maintenance and safety in chemical reactors. Severe accidents due to runaway reactions are in general related to an insufficient heat removal rate by the cooling system, resulting in a positive feedback mechanism accelerating the heat generation rate. A safe reactor is not only characterized by the complexity of its safety measure, but also by the way unexpected and unavoidable dangerous situations can be handled. Early warning devices are therefore indispensable.

The present early warning detection system is based on nonlinear time series analysis using delay coordinate embedding. This method opens a new route between the simple use of measured variables and the complex model-based state reconstruction techniques, to assess in advance hazardous situations in chemical reactors. The method relies on a special mathematical treatment of temperature measurements in order to reconstruct a phase space in which the divergence of the flow is conserved and can be used for early warning detection of run-away initiation.

A first advantage of the proposed method is an improvement in the definition of the boundary between safe and runaway operation. In addition the approach does not request any new measurement in addition with standard temperature sensors already installed.



### Stages of development

Patent	Priority date	02/06/1997
	Patent granted	US 6195010 CA 2291786 EP 0 882 499 JP 3,809,543

Method validated in calorimetric, bench scale and industrial reactors in the framework of the EU funded AWARD Project control.

### Innovative aspects and main advantages

- Less false alarms and earlier warning than existing methodologies.
- Uses a generalized definition of the boundary between Safe and Dangerous operations and therefore is applicable to all reactions and all types of reactors.
- It has been extended for on-line process control, chain optimization and other measurement series as financial time series

### Areas of application

- Safety of chemical reactor
- On-line process optimization and control of chemical process

### Scientific contact

Dr. Jose Zaldivar Comenges  
IES - JRC  
European Commission  
I-21020 Ispra - Italy  
Tel: (+39) 033278 9202  
Email address: jose.zaldivar-comenges@jrc.it

### Licensing contact

Intellectual Property and Scientific Collaboration Unit  
JRC - European Commission  
B-1049 Brussels, Belgium  
Email: JRC-TechTransfer@ec.europa.eu

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