Roberto Capata

Curriculum Vitae

Roma, January 2023

Part I – General Information

Full name:	**Roberto Capata**
Citizenship:	**Italian**

Parte II – Education

Type	Year	Institution	Notes (Degrees, Experience,…)
University	**1994**	**University of Roma "Sapienza"**	**Master Degree**
PhD	**2000**	**University of Roma "Sapienza"**	**Doctoral Degree**
Specialty	**2006**	**National Council of Research CNR**	**"Techniques and Methodologies of Energy Efficiency"**
Licensure	**2018**	**University of Roma "Sapienza"**	**1) Licensed Engineer, Roma 1995 ID n. 18399** **2) Training course for RADRL (University Manager for Teaching, Research and Laboratory Activities))**
ASN 2018	**2018**	**MIUR**	**Scientific Qualification as second level Professor (Associate Professor)**
Language	**2018**	**Faculty ICI - Sapienza**	**4) Shenker level C1 (75/100)**

III Appointments

IIIA – Academic Appointments

Start	End	Institution	Position
2001	**2003**	**Dept. Of Mechanics and Aeronautics**	**Junior Resercher**
2003	**2005**	**Dept. Of Mechanics and Aeronautics**	**Junior Resercher**
2006	**2008**	**Dept. Of Mechanics and Aeronautics**	**Junior Resercher**
2008	**2009**	**Dept. Of Mechanics and Aeronautics**	**Junior Resercher**
2009	**2012**	**G. MARCONI University**	**Assistant Professor (L. 230/05)**
2012	**2015**	**Dept. Of Mechanics and Aeronautics**	**Assistant Professor (L.240/10)**
2017	**2022**	**Dept. of Mechanical and Aerospace Engineering**	**Assistant Professor (L. 240/10)**

IIIB – Other Appointments

Start	End	Institution	Position
2011	**2011**	Ecoles de Saint Cyr Coetquidan	**Invited Professor**
2017	**2017**	University of Business & Technology (UBT) Pristina Kosovo	**Invited Professor**
2017	**2017**	YILDIZ Technical University Mechanical Engineering Faculty - Mechanical Engineering Department - Heat and Thermodynamics Division	**Invited Researcher**
2003	**2022**	State Exam for the qualification to the profession of Mechanical Engineer	**Member of Examination Board**
2017	**2017**	University of Tirana - 8th International Conference on Information Systems And Technology Innovations: Fostering the As-A- Service Economy	**Conference Invited Speaker & Session Chair**
2018	**present**	University of Roma "Sapienza"	**RADRL License**
2019	**present**	University of Roma "Sapienza"	**IT Updating Course**
2014	**2022**	Universidad de Deusto - Universidad de Bilbao Y San Sebastian (E)	**Assignee of Agreement**
2019	**2022**	Universidad de Zaragoza (Escuela de Ingeniería y Arquitectura) (E) Erasmus Research Contract	**Assignee of Agreement**
2019	**2022**	Tallinna Tehnikaulikool (EE) Erasmus Research Contract	**Assignee of Agreement**
2019	**2022**	Klaipedos Universitetas (LT) Erasmus Research Contract	**Assignee of Agreement**
2019	**2022**	Politechnika Gdanska (PL) Erasmus Research Contract	**Assignee of Agreement**
2017	**2022**	UBT – University of Business & Technology , Pristina (Kosovo) Research Contract	**Assignee of Agreement**
2012	**2022**	ASME IMECE (International Mechanical Engineering Congress and Exhibition) Congress	**Topic Organizer**
2012	**present**	ASME IMECE Congress	**Session Organizer**
2012	**present**	ASME IMECE Congress	**Session Chair**
2016	**2017**	ASME IMECE Congress	**Advanced Energy System Technical Chair**
2012	**present**	ECOS (International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems) Congress	**Session Organizer**
2012	**present**	ECOS Congress	**Session Chair**
2016	**2020**	Caesar – Spin Off Universitario	**Member**
2017	**present**	ESD – Energy for Sustainable Development – START UP	**Member**

2009	**present**	**Journal:** JERT (ASME Transactions), Energies, Energy, Energies, International Journal of Energy Research, Applied Sciences, Energy Science & Engineering, Vehicles, Electronics, Energy Ecology and Environment, Engineering Applications of Computational FluidMechanics, Machines, Microsystem Technologies https://publons.com/researcher/1169618/roberto-capata/	**Reviewer**
2019	**2019**	8th International Conference on Energy Efficiency Engineering IC - EEE 2019 (http://conferences.ubt-uni.net/2019/)	**Scientific Committee Member**
2019	**2019**	8th International Conference on Mechatronics, System Engineering and Robotics IC-MSER 2019 (http://conferences.ubt-uni.net/2019/)	**Scientific Committee Member**
2019	**2020**	1st World Energies Forum (https://wef.sciforum.net/)	**Congress Organizer, Conference Chair, Scientific Committee Member**
2020		Selection for Expert Evaluation of the risks deriving from the use of work machines and equipment (University of Rome "Sapienza")	**Member of Examination Board**

Part IV – Teaching Experience

Year	Institution	Lecture/Course
2004-2016	**Faculty of Engineering**	**Turbomacchinery:** Tutor & Lecturer
2005-2006	**Faculty of Engineering**	**Macchine operatrici idrauliche e Pneumatiche:** Tutor & Lecturer
2007-2011	**Faculty of Engineering**	**Hydraulic and Pneumatic Operating Machines:** Instructor
2009-2010	**Faculty of Engineering**	**Macchines I:** Lecturer
2010-2015	**Faculty of Engineering**	**Machine Diagnostics:** Instructor
2012-present	**Faculty of Engineering**	**Machines and Mechanics Applied to Machines:** Instructor
2014-present	**Faculty of Engineering**	**Macchine:** Instructor
2012-2015	**Faculty of Engineering**	**MASTER EFER di 2° Livello "Energy Efficiency and Renewable Energy Sources")** Lecture: *Review of energy systems and preliminary design of fluid machines*
July 2017	**UBT Summer School**	**Lecture:** *Financing Renewable Energy Projects with focus on Wind and PV*
2020-present	**Faculty of Engineering**	**Bio-machines:** Instructor
2018-present	**Faculty of Medicine**	**Energy and environmental systems - protection techniques**: Instructor

Part V - Society memberberships, Awards and Honors

Year	Title
2014-present	Member of the 'Editorial Board del Journal of "**Power and Energy Engineering**" - ISSN Print: 2327-588X ISSN Online: 2327-5901 - Website: http://www.scirp.org/journal/jpee/
2016-present	Member of the 'Editorial Board del Journal of "**Engineering Journal " (ENG)** - ISSN Print: 1947-3931 ISSn Online: 1947-394X - Website:http://www.scirp.org/journal/eng
2015-present	**ASME Member #8899627**

2014-2015	**Guest Editor for Energies Special Issue "Organic Rankine Cycle (ORC)" (ISSN 1996-1073) - ENERGIES. http://www.mdpi.com/journal/energies/special_issues/ORC2015 -2015**
2020-2021	**Special Guest Editor of Special Issue "Selected Papers from The First World Energies Forum (WEF-1)" - ENERGIES** https://www.mdpi.com/journal/energies/special_issues/WEF2020
2021-2022	**Guest Editor for Energies Special Issue " Frontiers in Hybrid Vehicles" - ENERGIES.** https://www.mdpi.com/journal/energies/special_issues/Frontiers_Hybrid_Vehicles

2018 - present	**Member of Innovative start-up "Engineering for Sustainable Development_ESD"**
2020 – present	**Member of Innovative start-up "Power Systems"**

Part VI – Research Activities

Keywords	Description
Ultra micro gas turbine (UMGT)	The impulse to study and to design miniaturized devices for the power generation derived from the crescent market demand for compact systems of such type, easy to transport and with larger autonomy, in contrast with the actual limits imposed by the conventional chemical type battery package, characterized by greater volumes and limited operational life. Currently we assist, thanks to the strong development of microelectronics and the micro-manufacturing, to the more and more capillary spread of portable devices and stand-alone systems, not connected to the grid and necessarily miniaturized, due to their application in aeronautical and aerospace field (drones, UAV, satellite devices), in the telecommunications (satellite mobiles, receivers), in medicine (field equipment and emergency devices), in computer science and the automation (robots, laptops). The choice to study the miniaturization of the Turbomachinery comes from a simple consideration of scale, for the highest power density (in comparison to any other device in commerce) that an ultra-micro gas turbine (UMGT) can supply: with diameters of the order of the centimeter/millimeter and precision to the micron, it is possible to produce within a range of 0.5 to 30 kW. Moreover, the actual commercial fuel is able to produce an energy density 20-30 times greater than the best commercial lithium battery package. If a good efficiency and reliability could be joined, the classic power generators could be replaced by these UMGT and, where redundancy in terms of safety is necessary, to adopt more devices in substitution of a battery pack, thanks to limited overall dimensions
Organic Rankine cycles (ORC)	We analyse the feasibility to insert "on-board" an innovative and patented ORC recovery system. In fact, the thermal source on the Lethe vehicle is a turbo gas device (according to the configuration chosen– city car or passenger sedan) within 10 to 30 kW. The energy surplus supply by the exhaust gases can usefully represent the thermal source for an ORC circuit, with which feeding the conditioning system and other several auxiliaries. The main characteristic of a "mini" ORC system to install on-board is its low power output. The plant has the following characteristics: the heat sources are the exhausts gases and, eventually, the oil and water from lubricating and cooling system; in the Lethe HV, where a 10-30 kW GT device is considered (depending on the type of chosen vehicle – city car or passenger sedan), the energy surplus is supplied by the exhausts gases. The high exhausts temperature can also feed an auxiliary conditioning system of the vehicle..

Hybrid vehicles

A longstanding interest of the Author' research group at UDR1 was the design, development and fielding of a road prototype of a new concept of Hybrid Series vehicle, endowed with a small Gas Turbine set as a thermal engine. In comparison with traditional internal combustion engines and even with the existing generation of Hybrid propulsive systems, this solution offers several advantages: a reduced engine weight and size, lower emissions, substantially extended range, ease of maintenance, and more efficient braking energy recovery. In the Lethe (Low Emissions Turbo-Hybrid Engine) the GT does not directly provide traction, but serves solely as a battery pack recharger. The vehicle is, in all respects, equivalent to a purely electric vehicle, except for the presence of an on-board recharger. Much care was placed in the design phase in the quest for an "optimal" design: first of all, an original method for identifying the most convenient degree of hybridization (ratio of the installed power of the battery pack and that of the GT) was defined and formalized, so that the resulting power balance between the two units satisfies two of the main design specifications, namely that of guaranteeing a practically acceptable operational life of the battery package and enabling the vehicle to complete a typical city mission (about 25-50 km) in a purely electric mode.

UAVs

In recent years, a renewed interest in the development of unmanned air vehicles (UAVs) led to a wide range of interesting applications in the fields of reconnaissance and surveillance. In these types of mission, the noise produced by propeller driven UAVs is a major drawback, which can be partially solved by installing an electric motor to drive the propeller. The evolution of high-performance brushless motors makes electric propulsion particularly appealing, at least for small and medium size UAVs. All electric propulsion systems developed to date are though penalized by the limited range/endurance that can be provided by a reasonably sized battery pack. In this paper we propose a hybrid propulsion system based on a recently developed, high efficiency micro-turbine which can be used to power an electric generator, thus providing a significant range/mission time extension.

Components

The design of micro and ultra-micro Turbomachinery introduces severe challenges due to the absence of a reliable and sufficiently extended database, so that the phenomenological differences among micro-turbomachines and between micro- and commercial-scale devices must be semi-empirically modelled from case to case. Scope of this study is to verify the possibility of extending the usual design correlations and maps to such small scales: specifically, this paper presents a procedure to conveniently modify the standard performance Balje map so that it can be adopted "as is" in the design of a micro and ultra-micro machines. The results of a systematic comparison with the general Stodola –like formula allow to extend the applicability of Re-corrected Balje and Smith charts to the range of Re ◎ 105. Moreover, regarding the ORC, the research deals with the comparison between volumetric expanders (screw, scroll and rotary vane) and an Inlet Forward Radial (IFR) micro turbine for the exploitation of an on-board Organic Rankine Cycle (ORC) energy recovery system. The sensible heat recovered from a common bus engine (typically 8000 cc) feeds the energy recovery system that can generate sufficient extra power to sustain the air conditioning system and part of the auxiliaries. The concept is suitable for all kind of thermally propelled vehicles, but the application considered here is specific for an urban bus. The ORC cycle performance is calculated by a Process Simulator (CAMEL Pro) and the results are discussed. A preliminary design of the considered expanders is proposed using ad-hoc made models implemented in MATLAB; the technical constraints inherent to each machine are listed in order to perform the optimal choice of the expander based on efficiency, reliability and power density. Last step will be the selection of the expander that suites the specific technical and design requests. The final choice relapsed on the screw motor, for it is the best

compromise in terms of efficiency, lubrication and reliability.

Branched and Compact Heat Exchangers

The aim is to evaluate three different compact branched heat exchangers, measuring, for every single device, the thermal efficiency and the pressure drop. The generality of the analysis of phenomena is enhanced by a comparison of the performance of different refrigerant fluids. In the first configuration, the channels have been designed, varying the inner diameter, to allow for an average constant flow speed throughout the exchanger. In the second one, the flow Reynolds number inside of the channels has been maintained constant. The last configuration is built according to the constructal diameter variation, as indicated in Bejan Constructal Theory. The exchanger manufacturing process is described. The test bench has been assembled using a hot source (Heating Plate with a power of 500 W) and a submersible pump, needed for the fluid recirculation, coupled with flowmeters, to control the mass flow rate within a specific range. The data obtained from several comparative tests have been analysed, to determine the optimal solution for each refrigerant among the different exchangers

Diagnostics of Thermal Power Systems

The reliability of gas path components (compressor, burners and turbines) of a gas turbine is generally high, when compared with those of other systems. However, in case of forced stops, downtime is usually high, with a relatively low availability. The purpose of conditions monitoring and faults diagnostics is to detect, isolate and evaluate (i.e., to estimate quantitatively the extent) defects within a system. One effective technique could provide a significant improvement in economic performance, reduce operating costs and maintenance, increase the availability and improve the level of safety achieved. However, conventional analytical techniques such as gas path analysis and its variants are limited in their engine diagnostic, due to several reasons, including their inability to effectively operate in the presence of noise measures, to distinguish anomalies of component from a failure sensor, to preserve the linearity in the relations between parameters of gas turbines and to manage the sensors range to achieve accurate diagnosis. In this paper, the approach of a diagnostic scenario to detect faults in the gas path of a gas turbine has been presented. The model provides a largescale integration of artificial neural networks designed to detect, isolate and evaluate failures during the operating conditions. The engine measurements are considered as input for the model, such as the speed, pressure, temperature and fuel flow rate. The output supplies any changes in the sensor or in the efficiency levels and flow rate, in the event of fault components. The diagnostic method has the ability to evaluate both anomalies of multiple components or multiple sensors, within the range of operating points. In the case of components failures, the system provides diagnostic changes in efficiency and flow rate, which can be interpreted to determine the nature of the physical problem. The technique has been applied in different operating conditions by comparing the results obtained with the solutions provided by linear and nonlinear analysis.

Machines in Biomedical Applications

The purpose of this research is to analyze the various applications in the field biomedical of fluid machines to highlight their critical issues and proposenew effective and innovative solutions. Through the detailed study of the system and with a view to maintaining the main biological functions, the various applications are considered. We therefore speak of machines for circulation extracorporeal (dialysis) and their optimization. Required a recall of hydraulics and the study of non-Newtonian fluids. The intent is to parameterize and then optimize the rotation speed of the roller pump to avoid blood hemolysis. Additionally, in the case of a linear pump, define the maximum displacement that does not harm the blood during its transfer. For anesthesia machines, the circuit is studied and optimised pneumatic and inserting machine more efficient and reliable by evaluating the various options and optimizing according to pulmonary compliance la machine. Added to this is the study of ventilation machines

pulmonary, of tragic actuality. Even for heart valves, there is a choice optimal and the intent is to indicate depending on the application the most confidant. In vacuum machines, a thorough study is required of the techniques for the choice and the realization of the vacuum. The machinery must be optimised, above all in the case of a coupling of several machines for the realization of the high vacuum, necessary for diagnostic tools such as CT scans. Machines such as liquid ring or lobe pumps need close scrutiny if they are to be matched. Finally, the search for a standard procedure for the creation of sterile areas both in the hospital and civil fields

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Part VIII – Scientific Activities

Prodotti	**Numero**	**Data Base**	**Start**	**Termine**
Papers [international]	54 (Journal) + 42 (Conference)	Scopus, WOS & MIUR	1996	present
Books [scientific]	1	Scopus, WOS & MIUR	2011	present
Books [teaching]	5	Scopus, WOS & MIUR	2012	present
Patent	2	Scopus, WOS & MIUR	2004	present
		Scopus, WOS & MIUR	2011	present

Totale Impact factor	22
Totale Citazioni	793 (Google Scholar) 517 (Scopus)
Media citazione per prodotto	19
Hirsch (H) index	**15 (Google Scholar), 12 (Scopus)**
H index normalizzato (10 anni)	24 (Google Scholar)

Part IX – Complete list of publications and other Research Activities
Complete list (date: MIUR/CINECA) of publications

- **Journal Papers** w. blind peer review: 54
- **Chapter in book**: 1
- **International Proceedings** w. blind peer review: 42
- **Monographic work/textbook**: 5
- **Patents**: 3
- **Supervisor** of **30 Master Degree Theses** in Mechanical Engineering, of **100 Batchelor Theses** in Biomedical and Clinical Engineering (dialysis machines, pulmonary ventilation, vacuum machines, hyperbaric chambers, infusion pumps, construction of sterile areas, anesthesia machines, biological and mechanical heart valves, O2/N2 and air supply systems, centrifugal machines for ECMO circuit, aortic valves, endobronchial valves) and **14 Batchelor Theses** Thesis in Chemical Engineering (Crude pumps, DeNox systems, construction of TiAl titanium aluminide turbine blades, preliminary design of reformed methanol fuel cells for automotive applications, new catalytic system for ICE, chemical optimization of renewable fuels for hybrid vehicles))

PUBLICATIONS

1. Capata R, Calabria A, Reale M., Geeothermal Application of Overhauled and Regenerated Steam Turbine. Proceedings of the ASME IMECE2022- 94916, October 30 - November 3, Columbus (OH) USA

2. Capata R, Calabria A. High-Performance Electric/Hybrid Vehicle—Environmental, Economic and Technical Assessments of Electrical Accumulators for Sustainable Mobility. Energies, 2022, 15(6), 2134

3. Capata R, L. Martellucci. High Performance Hybrid Vehicle Concept—Preliminary Study and Vehicle Packaging. Energies, 2022, 15(11), 4025

4. Capata, R. Experimental Fitting of Redesign Electrified Turbocompressor of a Novel Mild Hybrid Power Train for a City Car. Energies 2021, 14, 6516. https://doi.org/10.3390/en14206516

5. R. Capata, G. Piras (2021). Condenser Design for On-Board ORC Recovery System. Appl. Sci. 2021, 11(14),6356; https://doi.org/10.3390/app11146356

6. R Capata (2021). Preliminary Analysis of a New Power Train Concept for a City Hybrid Vehicle. DESIGNS (2021), vol. 5 (1), 19

7. Roberto Capata, Peristaltic Roller Pump: Parametric Optimization for Hemolysis Control. Proceedings of the ASME 2020 International Mechanical Engineering Congress and Exposition. IMECE2020- 21681, November 15-18, 2020, USA

8. R. Capata, E. Sciubba (2020). Study, Development and Prototyping of a Novel Mild Hybrid Power Train for a City Car: Design of the Turbocharger. APPLIED SCIENCES 2021, 11, 234. https://doi.org/10.3390/app11010234

9. R. Capata (2020). Expanders selection tool for small ORC systems. CPOTE-1113 Proceedings of 6th International Conference on Contemporary Problems of Thermal Engineering CPOTE 2020, 20-24 September 2020, Poland.

10. R. Capata (2020). New power train concept for a city hybrid vehicle. Sciforum-029149 Proceedings of the 1st World Energies Forum, Rome, September 2020

11. R. Capata, F. Tatti (2020). Designing, Prototyping, Assembling and Costs Analysis of a Gas Turbine Hybrid Vehicle. ENERGIES, vol. 13, p. 4611-4646, ISSN: 1996-1073, doi: 10.3390/en13184611

12. R. Capata, F. Pantano (2020). Expander design procedures and selection criterion for small rated organic rankine cycle systems. ENERGY SCIENCE & ENGINEERING, vol. 8, p. 1-35, ISSN: 2050-0505

13. R. Capata (2020). Macchine a Fluido – Volume 1. Ed. Esculapio, ISBN 978-88-9385-187-9

14. R. Capata, L. Gagliardi (2019). Experimental investigation on the Reynolds dependence of the performance of branched heat exchangers working with organic fluids. INTERNATIONAL JOURNAL of HEAT and MASS TRANSFER. Pub Date : 2019-06-06 , DOI: 10.1016/j.ijheatmasstransfer.2019.05.114

15. R. Capata, A. Calabria (2019). Optimal configuration selection through experimental tests on branched heat exchanger with r134 organic fluid. IMECE2019-10039 Proceedings ASME 2019 International Mechanical Engineering Congress and Exposition (IMECE2019), New York: ASME, Salt Lake City, 9-14 November 2019.

16. R. Capata (2018). Urban and extra-urban hybrid vehicles: A technological review. ENERGIES 2018 (11), 2924; https:// doi.org/10.3390/en11112924

17. R. Capata, M. Achille (2018). Design and optimization of fuel injection of a 50 kW micro Turbogas. DESIGNS, vol. 2, p. 1-22, ISSN: 2411-9660, DOI: 10.3390/designs2020014

18. R. Capata, M. Saracchini (2018). Experimental campaign tests on ultra-micro gas turbines, fuel supply comparison and optimization. ENERGIES, vol. 11, p. 799-815, ISSN: 1996-1073, DOI: 10.3390/en11040799

19. R. Capata, B. Andrea, F. Felli, D. Pilone, E. Sciubba (2017). Preliminary design, modeling, production, and first evaluation tests of a Ti-Al gas turbine blade. J. of ENGINEERING MATERIALS and TECHNOLOGY, vol. 139, ISSN: 0094-4289, DOI: 10.1115/1.4035894

20. R. Capata, A. Beyene (2017). Experimental evaluation of three different Configurations of constructal disc-shaped heat exchangers. International journal of HEAT and MASS TRANSFER, vol. 115, p. 92-101, ISSN: 0017-9310, DOI: 10.1016/j.ijheatmasstransfer.2017.06.096

21. R. Capata, F. Pantano (2017). A comparison between a Microturbine and a scroll-type expander for a small scale ORC energy recovery system for vehicular application. In: Proceedings ASME 2017 International Mechanical Engineering Congress and Exposition (IMECE2017). P. 1-9, New York: ASME, Tampa Bay, 3-9 November 2017

22. R. Capata, F. Pantano (2017). Expander selection for an on board ORC energy recovery system. ENERGY, vol. Volume 141, p. 1084-1096, ISSN: 0360-5442, DOI: 10.1016/j.energy.2017.09.142

23. R. Capata (2016). An artificial neural network-based diagnostic methodology for gas turbine path analysis—Part I: introduction. ENERGY, ECOLOGY and ENVIRONMENT, p. 1-8, ISSN: 2363-8338

24. R. Capata (2016). An artificial neural network-based diagnostic methodology for gas turbine path analysis—part II: case study. ENERGY, ECOLOGY and ENVIRONMENT, p. 1-9, ISSN: 2363-8338, DOI: 10.1007/s40974-016-0042-7

25. R. Capata, K. Bylykbashi, F. Testa (2016). A model proposal for the electric energy valorization in a PV power plant equipped with CAES system. International Journal Of SCIENCE, INNOVATION & NEW TECHNOLOGY, vol. 1, p. 1-10, ISSN: 2223-2257

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29. R. Capata (2016). Implementing a hybrid series bus with gas turbine device - a preliminary study. International JOURNAL of ADVANCED ENGINEERING RESEARCH and SCIENCE, vol. 3, p. 135-143, ISSN: 2349-6495

30. R. Capata, E. Sciubba, A. Brotzu, F. Felli, D. Pilone, L. Menna (2015). Design, prototyping and preliminary testing of a Ti-Al gas Turbine blade. In: ASME IMECE2015. Vol. IMECE2015-50058, New York: ASME, Houston, Texas - USA, 14-19 november

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morphological comparison. MICROMACHINES, vol. Volume 6, p. 1710-1728, ISSN: 2072-666x, DOI:10.3390/mi6111451

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42. R. Capata, A. Calabria, M. Di Veroli (2014). Complementi di macchine - esercizi di macchine a fluido. P. 1-171, ISBN: 9788895706412

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