

COMMENT OPEN



Father of reverse osmosis who made a huge impact on our world: Srinivasa Sourirajan (October 16, 1923–February 20, 2022)

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Field openers should be admired for leading the crowds. This comment is relevant to the bigger picture of Professor Sourirajan to highlight how a humble talent had selflessly founded a multicontinental major, which scaled up to US\$ 50 billion in the 2021 global membrane separation market to enrich the quality of worldwide life via providing clean water.

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Water, food and sanitation in their current status owe a lot to the transformative discoveries of Srinivasa Sourirajan. This is why Roberto Goizueta Professor Menachem Elimelech asserted that “he should have received two Nobel Prizes- one for science and one for peace”¹. Sourirajan shared this fundamental discovery with Sydney Loeb. It was patented in 1964. The architecture of a symmetric membrane using cellulose acetate solved a puzzle 200 years old: scalable synthetic membrane fabrication.

Their design of a desalination membrane that selectively separates sodium chloride and dissolved solids under pressure while allowing water to pass through, all using cellulose acetate, was awarded multiple prizes. Today, two-thirds of desalination plants are based on reverse osmosis worldwide. Sourirajan has died, aged 98.

Factually, organic chemists focused on making synthetic membranes for two centuries. Instead, in 1962, Sourirajan developed the non-solvent induced phase separation (NIPS) process, which is still the most popular method for fabrication of integrally-skinned asymmetric membranes of all types. The so-synthesized membrane is then used as a barrier for separation processes such as desalination.

He defended his second Ph.D. thesis entitled “The System Water-Sodium-Chloride at Elevated Temperatures and Pressures” in August 1961, which mainly focused on the vapor pressure of saturated aqueous sodium chloride solutions and the solubilities of sodium chloride in water in the gas-solid and gas-liquid equilibrium regions, at Yale University. Excluding books and tens of patents, he left a heritage of over a hundred publications -*Nature*, 199 (1963) 590–591; *Nature*, 203 (1964) 1348–1349- and generations of membrane scientists plus worldwide membrane centers, which led to a 50 billion USD market; more importantly, clean water.

Sourirajan was born in a village in southern India in 1923; he was among the first wave of young Indians in post-colonial India to receive a Doctorate in chemistry. Professor Paul Emmett of Johns Hopkins University, a world pioneer in catalysis, was impressed with his research thesis. Emmett’s interest led him to Yale University in the U.S. in the mid-1950s, where he obtained his second Ph.D. in Chemical Engineering. He started work as a research scientist at UCLA in 1956 and made significant contributions in three areas. First, he pioneered new research

procedures and techniques that resulted in innovative geophysics data. Second, his groundbreaking catalysis work paved the way for the production of unleaded gasoline to combat the smog problem. Finally, and perhaps most importantly, he invented current reverse osmosis. (Srinivasa Sourirajan, *Ottawa Citizen*, 2022, <https://ottawacitizen.remembering.ca/obituary/srinivasa-sourirajan-1084507224>).

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At the beginning of the 1960s, Sourirajan settled in Ottawa, where he worked as a research scientist for the National Research Council for 25 years. In the 1960s, his work and reputation made the National Research Council the world’s leading center for membrane research, attracting renowned scientists worldwide. His expertise in reverse osmosis prompted global firms like Dupont to develop commercial and industrial applications. He formed the Industrial Membrane Research Institute in the Department of Chemical Engineering at the University of Ottawa after retiring from the National Research Council in 1986 to teach the next generation of scientists. Dr. Sourirajan moved to National University of Singapore in 1991 to start a membrane research lab. (Dr. Srinivasa Sourirajan, *National Research Council Canada*, 2022, <https://nrc.canada.ca/en/stories/dr-srinivasa-sourirajan>).

Over his life, Sourirajan received various honors and medals, including an Honorary Doctorate from the University of Ottawa (1994); he was inducted into the American Membrane Technology Association Hall of Fame in 2016. Sourirajan was named one of the top-performing chemical engineers of the twentieth century by the Canadian Chemical Engineering Conference. The scientific community praised him for his contributions as a scientist, inventor, and philosopher.

In addition to his scientific legacy, Sourirajan was among the first Indian immigrants who settled and raised their families in Ottawa and was active in helping to build the Indian community there. Sourirajan is everlastingly survived in every droplet of desalinated water, in his publications cited in nearly 2000 Scopus indexed documents and over 4000 on Google Scholar, and in the generations of membrane scientists educated by his teaching.

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COMPETING INTERESTS

The author declares no competing interests.

ADDITIONAL INFORMATION

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