Going green with algae

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Once known only as the slimy scourge of backyard ponds and lakes, algae is emerging as a superhero in the race for cleaner and renewable energy resources. But this hero is not without its Achilles' heel: Although its proliferation across water bodies might make it appear invincible, algae is actually fragile – vulnerable to fluctuations in weather and temperature – limiting commercial growers and researchers alike in their selection of growing systems and locations.

But a new, outdoor system at the University of Dayton Research Institute has been producing a high volume of algae since its installation in the summer of 2013, even through this especially harsh Ohio winter.

"This is a fully automated, closed system designed to operate 24/7, 365, regardless of the weather," said Sukh Sidhu, head of the Research Institute's energy technologies and materials division. "Our goal was to design and build an economical and efficient system that could be transported anywhere, easily assembled and operate in any climate, and we've done just that."

The system – a scaled-up version of an indoor research system still operating in a Research Institute lab – is less costly to operate than similar systems, but is already producing algae at a target rate established by the Department of Energy, Sidhu said.

"This is all about cleaner air, cleaner water and cleaner energies," Sidhu said. "Algae feeds on carbon dioxide and converts it to a highly desirable oil, which accounts for as much as 70 percent of the organism's body

weight in some strains. So we can capture carbon dioxide from stacks of coal boilers and other combustion processes before it's released into the atmosphere and run it through algae growing systems. We consider this a far better alternative for dealing with CO2 emissions than geosequestration, where carbon dioxide is pumped deep into the earth."

In turn algae oil can be extracted and, along with the proteins and carbohydrates that also make up the body of algae, used to create renewable resources for biofuel.

Because algae also needs nitrogen and phosphorus to survive, it can remove those elements from municipal and industrial wastewater before it's discharged into rivers and lakes, reducing the need for expensive treatments typically used to clean wastewater. It can also be used to capture fertilizers in agricultural runoff, then used as a fertilizer itself.

The Research Institute has been performing research, testing and development of algae and algae-growing systems for pollution control and alternative energies since 2009 under funding from the Air Force Research Laboratory Materials and Manufacturing Directorate. Initial research was focused on testing varieties of algae and light and other growing conditions for optimal production, as well as best methods of extracting oil.

"We discovered that there are no 'best strains' of algae, but that the key factors to high yield are environmental – factors such as weather and temperature, which can be so unpredictable," Sidhu said. "That's why most systems are open, such as natural or man-made ponds, and found in warmer climates.

And that's why our system is different. It will operate well in any location, regardless of season or climate."

There are other significant differences, Sidhu said. Aside from being more cost efficient, the Research Institute's growing process is greener – in the environmental sense – than most systems, which use chemical fertilizer as a nutrient source for the algae.

"Producing algae with fertilizer is expensive and leaves a huge carbon footprint. We use livestock and chicken manure – the same type of nutrient source responsible for the algae blooms at Grand Lake St. Mary's Ohio and other lakes affected by agricultural runoff," Sidhu said.

Sidhu said his research team studied a number of closed tubular growing systems in addition to performing their own research before developing the new system, which includes proprietary design modifications engineered by program principal investigator Moshan Kahandawala.

After demonstrating the technology, the next step will be commercialization, Sidhu said.

Provided by University of Dayton