By Terran Reneau

Save Water and Money

Understanding golf course water distribution uniformity

Golf course superintendents and specifiers are faced with a difficult balancing act--managing the world's most precious resource while still providing the irrigation that their courses need to stay profitable.

Today, there is greater attention on water conservation than at any other time in our history, and because golf courses are highly-visible consumers of water, they stand out as targets for scrutiny--especially in drought-prone, arid regions like the American Southwest.

Designing irrigation systems that deliver the most uniform water distribution over the course is an important task for both golf course specifiers and superintendents.

Why? Because applying water uniformly decreases the amount of water used overall without sacrificing playability.

Optimizing the amount of water used also benefits the course by lowering water costs and decreasing its carbon energy foot print through reduced pump run times.

To fully optimize a course's water distribution uniformity, it's imperative to understand the thresholds necessary to achieve exceptional course playability without wasting water.

FINDING UNIFORMITY

Conceptually, achieving water distribution uniformity seems pretty simple; find the best sprinklers available that apply water with perfect uniformity over every square inch of turfgrass, without creating wet spots or failing to address dry areas.

However, in reality, no sprinkler system--including natural rainfall--is capable of 100 percent uniform water application.

Wind, terrain, sprinkler spacing and spray droplet sizes are among the many factors that impact a sprinkler's ability to cover an area uniformly.

The goal of every golf sprinkler manufacturer should be to create products that distribute water as uniformly as possible.

So, how much water to apply? That's a question always on the top of superintendents' minds as they manage wet and dry spots, syringe critical areas and monitor water and environmental conditions on the course.

Quite often, decisions are made based on past experiences that may or may not apply under unique circumstances.

Using golf sprinklers that deliver the best, most uniform amounts of water will result in lower water usage and costs with less time spent chasing variables.

Likewise, sprinklers with poor uniformity or erratic operation can complicate this process, resulting in higher water use to maintain course playability.

SPRINKLERS & NOZZLES

The design of high performance sprinklers and nozzles directly affects the amount water distribution uniformity over the course, but these products are the most commonly misunderstood of all irrigation system components.

Knowing more about the science of measuring sprinkler water distribution capabilities leads to a better understanding of how to select the best golf sprinklers for a particular course.

CATCH CANS

When we talk about distribution uniformity (DU), we are describing how evenly water is applied over a given area. DU is generally considered a measurement of a sprinkler's ability to provide water application uniformity.

This is calculated by measuring the volume of water collected in a number of "catch cans" placed in an area of sprinkler coverage during a timed application.

The volume of water collected from each catch can is recorded, and the average of the lowest quarter of the catch cans is divided into the average of all the catch cans.

The resulting number is expressed as a percentage referred to as its distribution uniformity (DU). Higher DU percentages mean better water distribution uniformity; the lower the DU, the more uneven and under-watered areas that will exist on the course.

DENSOGRAMS

To correct lower DUs, the typical course increases its sprinkler run times to compensate for the drier spots within the coverage area. However, this practice can obviously lead to wasted water on other areas of the course.

To help designers and superintendents select sprinklers and nozzles that achieve the best DU, the Center of Irrigation Technology developed a graphic model representation of distribution uniformity called a "densogram."

Densograms provide an excellent visual depiction of intensity, showing the high and low watering spots along with their respective moisture levels.

This model makes it much easier to see the distribution uniformity of any watering application. Below are examples of two densograms with different spacing schemes: equilateral versus square.

This does not take into account the location or benefits of immediately-adjacent, higher-water applications or terrain influences.

However, it does demonstrate some significant variation in sprinkler DU performance and spacing effects.

Following the Irrigation Association Audit Guidelines, sprinkler DU measurements are typically performed by placing catch cans in a geometric pattern within the area of coverage of multiple sprinklers on the golf course.

Another means of determining coverage uniformity is to create a "single leg profile" where catch cans are spaced every 2 feet from the sprinkler to the extent of its throw.

The data measured by these methods is then entered into the Center of Irrigation's "SPACE" software program where different rotor/nozzle/spacing combinations can be simulated for optimization.

Single leg tests are normally performed in a laboratory test facility under zero wind conditions. Removing the wind variable increases the ability to accurately measure one sprinkler's DU performance against another's, effectively evening the playing field.

This allows manufacturers to measure best possible DU sprinkler performance along with precise mean precipitation rates at multiple distances from the sprinkler head.

The Center for Irrigation Technology's tool is capable of modeling multiple sprinkler configurations in equilateral and rectangular spacing at varying head-to-head distances.

The program outputs DU, scheduling coefficients (SC), precipitation measurements and visual water uniformity densograms as seen in the previous examples.

A scheduling coefficient is the measure of the lowest precipitation rate for critical turfgrass areas compared to the overall average of an entire area. SC indicates the amount of water needed to adequately water the driest critical areas of turfgrass.

DU considers the average dryness percentage of the entire area; a dry reading next to a wet area is more modulated.

The Irrigation Association (IA) has also determined a formula for a Run Time Multiplier (RTM) that can be used to calculate the number of additional minutes of sprinkler run time required to compensate for the lack of perfect water distribution uniformity.

To make it easier, the IA has published an RTM conversion table that

Run Time Multiplier (RTM) DU Conversion Table

DULQ	RTM	DULQ	RTM	DULQ	RTM
100	1.00	70	1.22	40	1.56
98	1.01	68	1.24	39	1.58
96	1.02	66	1.26	36	1.62
94	1.04	64	1.28	33	1.67
92	1.05	62	1.30	30	1.72
90	1.06	60	1.32	27	1.78
88	1.08	58	1.34	24	1.84
86	1.09	56	1.36	21	1.90
84	1.11	54	1.38	18	1.97
82	1.12	52	1.40	15	2.04
80	1.14	50	1.43	12	2.12
78	1.15	48	1.45	9	2.20
76	1.17	46	1.48	6	2.29
74	1.18	44	1.51	3	2.39
72	1.20	42	1.53	0	2.50

converts DU into a run time percentage. Highlighted are the DU's from the previous densogram examples to contrast these run time savings.

You can see from the above example that having a sprinkler with a 90 percent DU versus a 76 percent DU would have a run time savings of almost 10 percent per irrigation cycle. This may seem somewhat insignificant, but it has a huge impact on water savings, costs and pump run times.

The following table illustrates a hypothetical cost analysis that puts this impact into better focus. In this example, a superintendent could realize a $26,683 savings annually over the life of a 20-year irrigation system—that's a savings of 256 million gallons of water and $533,652! The amount of potable water a course like this could save per year would be enough to supply the annual needs of 148 typical households.

Considering water savings in these terms can also offer golf courses a tremendous amount of positive publicity and marketing opportunities related to their proactive environmental approach to saving water.

While using the highest DU sprinklers available is certainly important, using sprinklers that perform consistently year over year is equally important.

For example, Rain Bird Corporation performed random audit testing on multiple courses with various manufacturers' sprinklers and noted some competitor courses with

Pump Operating Capacity GPM	DU_{LQ}	Sprinkler RTM	Average Watering Window (hrs) per day	Total Gallons/day	Avg # Irrigation days/yr.	Millon Gallons per/yr	Equiv. 100 c.f. (100 c.f. = 748 Gallons)	Cost Per Cubic Feet	Total Watering Costs $	Incremental Water Cost	Incremental water Volume (%)
1500	98%	1.01	6.0	540,000	240	130	173,262	$1.40	$ 242,567	--	--
	94%	1.04	6.2	561,600		135	180,193		$ 252,270	$ 9,703	3.8%
	90%	1.06	6.4	572,400		137	183,658		$ 257,121	$ 14,554	5.7%
	84%	1.11	6.7	599,400		144	192,321		$ 269,249	$ 26,683	9.9%
	80%	1.14	6.8	615,600		148	197,519		$ 276,527	$ 33,960	12.3%
	76%	1.17	7.0	631,800		152	202,717		$ 283,804	$ 41,237	14.5%
	74%	1.18	7.1	637,200		153	204,449		$ 286,229	$ 43,662	15.3%
	70%	1.22	7.3	658,800		158	211,380		$ 295,932	$ 53,365	18.0%
	64%	1.28	7.7	691,200		166	221,775		$ 310,485	$ 67,918	21.9%
	60%	1.32	7.9	712,800		171	228,706		$ 320,188	$ 77,622	24.2%
	54%	1.38	8.3	745,200		179	239,102		$ 334,743	$ 92,176	27.5%
	50%	1.43	8.6	772,200		185	247,765		$ 346,871	$ 104,304	30.1%
	44%	1.51	9.1	815,400		196	261,626		$ 366,276	$ 123,710	33.8%
	40%	1.56	9.4	842,400		202	270,289		$ 378,405	$ 135,838	35.9%
	36%	1.62	9.7	874,800		210	280,684		$ 392,958	$ 150,391	38.3%

* A Typcial Family of four's water useage is 260 gallons per day or 94,900 per year.

irrigation systems 5-10 years old and DU's in the 30-40 percent range.

These DU's are typically much lower than what was measured on the initial installation audits by the courses and are outside of the specifications for the sprinklers on the course. It is key to periodically perform an IA standard guideline audit on a course to ensure it's fine-tuned for performance and savings.

To go "green" in today's environmentally-conscious world, look for these key ingredients to optimize your course's playability while saving both water and money:

Optimize your head-to-head spacing and nozzle selections

Select sprinklers with the highest DU performance modeled on the Center for Irrigation Technology's software programs for your application

Nothing is perfect, so look for sprinklers with DU's that are as close to 100 percent as possible

Utilize the Irrigation Association's RTM table to estimate your optimal watering times

Select a sprinklers that are the most durable, able to stand up to the harshest environments while giving you consistently high DU's year after year with the lowest run time performance

By following these few steps you'll also leave some green in your golf course's pockets!

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