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ISRAQUA and ICID irrigation conferences

New developments in irrigation and drainage were discussed at two recent international conferences. The Tenth International Commission on Irrigation and Drainage (ICID) Congress on Irrigation and Drainage was held in Athens, Greece. The ISRAQUA '78 International Conference on Water Systems and Applications was held in Tel Aviv, Israel. Irrigation has expanded throughout the world during the past 2 or 3 decades. Most countries now depend on irrigated agriculture to increase and stabilize food and fiber production for their expanding populations. These international conferences, attended by engineers and policymakers involved in the design and operation of irrigation systems, provide a means to exchange experience and knowledge. Information and experience gained in one country often can be used in another. Some interesting and new approaches are described in this article.

ICID Conference (Athens)

Drainage—latest subsurface drainage techniques and construction methods.

A new bi-level subsurface drainage system was proposed. This system consists of alternate deep and shallow parallel drain lines. The deep drains are installed by the trenching method while the alternate shallow drains are plastic drain tubing "plowed-in" by the trenchless method.

A computer simulation study showed that for many situations the bi-level system costs less than a comparable single-level system where the shallow drains can be installed at one half or less the cost of the deep drains. This system can be used where it is necessary to control salinity, particularly during periods of maximum water table elevations, and to provide additional drainage capacity in existing systems. Variations of this technique are being used in several countries to drain heavy soils. Deep drains with permeable trench backfills are combined with deep plowing, ripping and mole drains perpendicular to the deep drains to improve drainage of the surface soil.

Another interesting technique being developed in Poland and the USSR to improve the drainage efficiency of heavy soils is that of vacuum drainage. The amount of drainage effluent was increased 26% when an automatic self-priming siphon device was used to create a vacuum of approximately one foot of water column in the system. Horizontal vacuum drainage in another system uses a closed, conventional drainage network with a hermetically sealed well and vacuum pump. In another vertical vacuum drainage system, both air and water are pumped separately from a series of interconnected wells. With these systems, drains at half the depth produced about as much drainage as conventional drains and the drainage effluent had a higher salinity content. Saline lands can be reclaimed faster by this method.

The existence of a critical subsoiling and mole drain formation depth was reported. At depths shallower than the critical depth, a subsoil or ripper tine shatters and lifts the soil, whereas, below this depth, the soil fails by plastic flow; the soil structure is not greatly disturbed but instead a hole is formed as the implement moves through the soil. Thus, if the objective is to break up and shatter the soil, such as in the case of subsoiling to break a hardpan or to create passages for water flow, then the implement must be shallower than the critical depth. The critical depth varies with machine geometry, soil properties, soil moisture and similar factors and for typical soils in England is above 16 inches.

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Use of the laser for grade control, noted in a large number of the reports, has made possible the hi-speed trenchless method of installing drains. Two major types of drain-laying machinery are predominantly used: trenchers and trenchless, and both use laser beam control. Experiences vary somewhat from country to country but in most the speed of drain pipe laying by trenchless methods is about twice that of trenchers. Advantages and disadvantages were reported for both methods. Trenchless methods are more likely to be restricted by weather and poor tractive conditions and are not always satisfactory in heavy soils. They are more satisfactory in lighter soils and overall, the cost of trenchless drainage is about 15-20 percent lower than trenching methods; however, there is wide variation in costs due to different conditions.

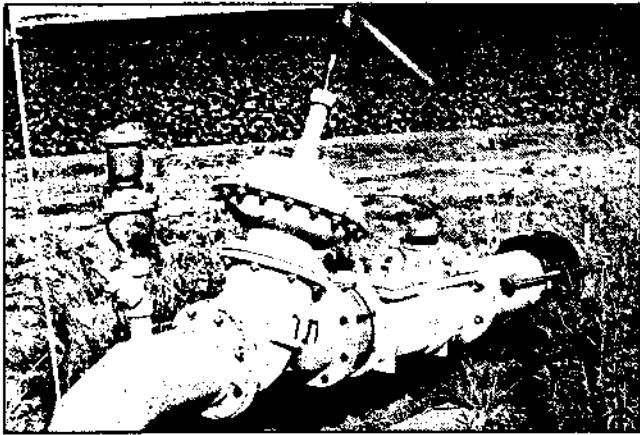
Anti-oc-filters, a relatively new development for preventing ochre clogging of drain pipes, were discussed. These contain a substance that discourages the formation of ochre which is a slimy, gelatinous-iron, precipitate material that usually contains some silt. It is formed in drain pipes by a biochemical action that occurs in water containing soluble iron and manganese compounds in the presence of oxygen. Ochre clogging is a problem in some areas of the U.S., particularly in the Southeast.

Remote sensing techniques using Landsat and aircraft photographic imagery for delineating areas that need drainage and recent studies on the hydraulics of plastic drain tubing were also discussed.

System operation, maintenance and modernization

Many irrigation systems worldwide have been designed and constructed with inadequate consideration given to their continued operation, maintenance and modernization. Several factors have contributed to this. The prestige associated with the design and construction of a visible, impressive irrigation system is usually greater than that associated with its operation and maintenance (O&M). Approval and construction of a project often has an immediate political payoff for government officials and others associated with it while their term in office is sometimes so short that they are not always around to follow up on O & M. O & M often has a low priority for funds and funds received from the system revenue sometimes do not go directly to the operating organization. Maintenance and rehabilitation have sometimes been postponed as long as possible in an attempt to keep current operating costs low.

Deficiencies were noted in many



Automatic flow metering valves have helped Israel conserve water.

irrigation systems by the conference speakers. Additional reservoir storage, particularly for regulation, is needed to provide greater flexibility in farm deliveries as required by automated farm systems. Uncontrolled, unmeasured, and leaky diversion structures and canal outlets are still problems. Canal seepage is responsible for much water loss and many canals need repair and/or lining. Some canals provide near continuous or year-round deliveries and shutdown time when repairs and improvements can be made is very limited. Weeds and moss in unlined water channels are a continuing problem. Inadequate irrigation facilities on the farm combined with poor management results in poor water distribution, overuse and wastage. System capacity is sometimes deficient because crops having higher ET requirements than those for which the system was designed are being grown and additional land is being irrigated. Many older systems have become obsolete because of new technology and do not satisfy today's farming needs; their modernization is needed to fully utilize present technology such as automation.

In addition to the normal operation, repair, and maintenance practices common to most systems, several techniques are being used to modernize some systems. Computers are being used to model and simulate project operation as well as for monitor and control functions. Telecommunications, remote control, and automation are being installed in many systems. Replacing open channels with pipelines, both in distribution systems and on farms, is a worldwide trend. For example, O & M costs for the Garland Division of the Shoshone Project in Wyoming are estimated to be reduced by at least 25% by converting from an open to a closed system. A novel means of rehabilitating an old unreinforced cast-in-place concrete pipeline in California was used. A reinforced, plastic mortar liner-pipe was installed inside of the concrete pipe. Improved farm irrigation systems and a field demonstration program to increase irrigation

efficiency in India resulted in yield increases of 15 to 30 percent with only about one-half of the water that was previously used.

In the U.S., the Bureau of Reclamation has a program of periodic on-site inspections once each 2 or 3 years of all facilities constructed and operated by the Bureau and those for which user-operator contracts are still valid. Through the Rehabilitation and Betterment Act, repairs, rehabilitation, and improvements which are beyond the scope of the normal system revenue can be made. For non-Federal projects or systems, loans and grants for financing system improvements and modernization can be obtained through the Small Reclamation Projects Act of 1956.

A unique automated farm system is being developed in Bulgaria. This system uses underground pipe distribution laterals with telescoping risers. The risers are manually pushed below ground level at the end of the irrigation season and rise to the surface automatically when the pipeline is filled with water under pressure. Automatic valves which operate from the water pressure in the pipeline, similar to those developed at the Snake River Conservation Research Center in Kimberly, Idaho, are used to control water flow in the distribution pipelines. The cost of the system with a 1000 feet length-of-run between laterals was reported to be about \$250 per acre.

ISRAQUA '78 (Tel Aviv)

Israel's water supply is severely limited because of its geography and climate. Consequently, much effort has been given to obtain the maximum benefit from the available water and highly efficient irrigation systems and practices have been developed. Some of these developments along with current practices and studies were reviewed at the ISRAQUA Conference.

Virtually all (95%) of the country's water supply is fully utilized and is sufficient for only about 25% of the potentially irrigable lands. Approximately 60% of the water is from ground water and 40% from surface sources. Israeli

water law is administered so that, besides limiting the amount of water allocated, there are incentives for efficient use. For example, the amount allocated is based on crop requirements and soils according to norms calculated for maximum efficient use and the price of water rises sharply for quantities used in excess of these standard amounts. Also, if a farmer becomes more efficient and uses less water he can use the saved water to irrigate additional land. During the past 12 years, the amount of water input per acre was reduced 20% while at the same time the value of agricultural production at constant prices increased 100% compared to 1960. Israel's irrigation efficiency is considered among the highest in the world and overall efficiency from source to plant ranges from 70 to 80%. In the 10 years following the implementation of Israel's water conserving programs, water use efficiency in agriculture and industry increased 300%.

Approximately 85% of the acreage is irrigated by sprinklers, 10% by drip or trickle and the remaining 5% by gravity methods. Most of the fields are relatively small compared to those in the U.S. and highly diversified crops including fruits and vegetables are grown.

One of the most effective means of conserving water has been the development and use of automatic flow metering valves such as the one shown in the photo. These control the timing and quantity of water delivered or applied and virtually all water is metered. Flow metering valves terminate the delivery after a certain volume of water has passed and can be sequentially operated by an electronic or hydraulic pulse from one to another, by individual timers, or by programmed irrigation controllers. Automation in Israel is based on these volume-control valves. Different levels of automation are used ranging from automated individual farm delivery points and fields, to farm blocks and entire farms, to completely automated, computer-controlled systems with a centralized controller. These computer-based systems are a recent development and have certain decision-making capability based upon water availability, climatic conditions, soil properties, field status reports and measurements, and system conditions. Flow and pressure regulators are used extensively to improve the water distribution uniformity of sprinkler systems. Drip irrigation is well suited to Israeli conditions and was first used there.

Even though conditions in Israel are perhaps more favorable for using intensive, highly sophisticated irrigation systems, much of their technology can be

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Conferences

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used here in the U.S. For example, volume-control valves can be used with our stationary sprinkler systems. Metering valves can be used in existing surface systems also where uniform water distribution in the field can be obtained, such as with level basins and borders that are well graded and maintained. They could also be used in furrow systems where buried mainlines and/or gated pipe are used with good field surface preparation and relatively short lengths of run. In general, we need to improve our surface distribution systems so that uniform water distribution is consistently obtained before water can be successfully metered volumetrically to the field. Applying water to a field by "time" accomplishes the same objective where water deliveries are constant and measured. However, since many deliveries are not measured and irrigators often do not calculate the actual volume or depth of water applied, individual field irrigation efficiencies could be increased by using volumetric controls. Present flow metering valves were designed primarily for use in pressurized systems such as sprinkler and drip and may need to be modified for use in low pressure surface systems. Alternatively, a metering valve designed specifically for low pressure systems needs to be developed.

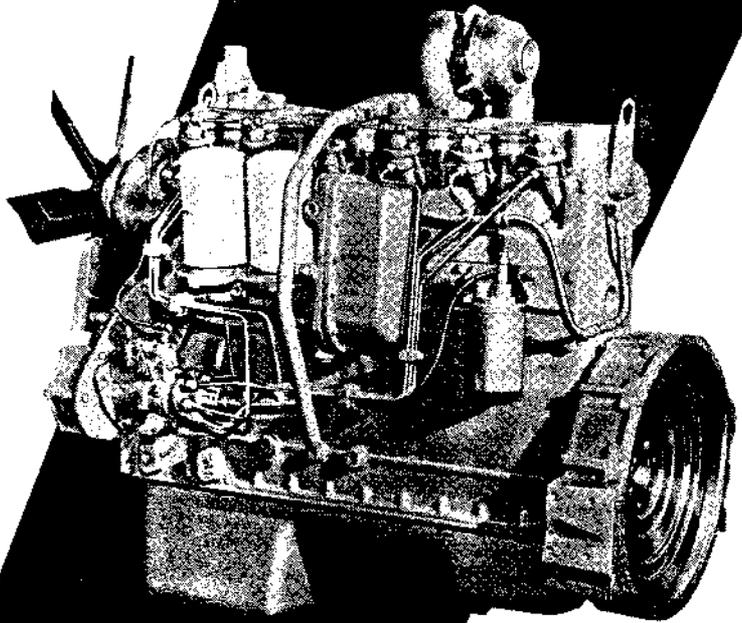
Other studies and programs include plant water studies to determine the relationship between water transpired and plant growth and irrigation requirements. Techniques are being developed for economically irrigating row crops such as cotton and corn by trickle irrigation. An interesting approach to closed system agriculture is being investigated using greenhouses in a desert environment. Solar energy collected in the greenhouse during the day is stored and used for night time heating. Plants grown in the humid, high CO₂ greenhouse environment require only 0.1 to 0.2 as much water as when grown in the open and are less sensitive to salinity. A farmer can make a comparable living on only 1/20 the acreage as in normal farming and, thus, will use only 1/2 to 1% as much water. It may be feasible to use desalinated water with this method. Extensive use is made of underground reservoirs for water storage. The underground reservoirs are recharged through wells with water accumulated during wet years and seasons for use during the dry periods. Active programs are also underway in seawater desalination and solar energy utilization.

The old saying that necessity is the mother of invention has proven true in Israel where water is concerned. ▼

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