

# On-Line BOD-COD Pollution Monitoring System(OPMS)

ระบบตรวจสอบมลพิษระยะไกล



## ประกาศ/ระเบียบที่เกี่ยวข้อง

- เรืองกำหนดให้โรงงานที่ต้องมีระบบบำบัดน้ำเสียต้องติดตั้งเครื่องมือหรือเครื่องอุปกรณ์พิเศษและเครื่องมือหรือเครื่องอุปกรณ์เพิ่มเติม พ.ศ. 2547 ลงวันที่ 2 ก.ค. 2547
- เรืองกำหนดให้โรงงานที่ต้องมีระบบบำบัดน้ำเสียต้องติดตั้งเครื่องมือหรือเครื่องอุปกรณ์พิเศษและเครื่องมือหรือเครื่องอุปกรณ์เพิ่มเติม (ฉบับที่ 2) พ.ศ. 2548 ลงวันที่ 7 ม.ค. 2548
- เรืองกำหนดให้โรงงานที่ต้องมีระบบบำบัดน้ำเสียต้องติดตั้งเครื่องมือหรือเครื่องอุปกรณ์พิเศษและเครื่องมือหรือเครื่องอุปกรณ์เพิ่มเติม (ฉบับที่ 3) พ.ศ. 2549 ลงวันที่ 11 ก.ย. 2549
- เรืองกำหนดให้โรงงานที่ต้องมีระบบบำบัดน้ำเสียต้องติดตั้งเครื่องมือหรือเครื่องอุปกรณ์พิเศษและเครื่องมือหรือเครื่องอุปกรณ์เพิ่มเติม (ฉบับที่ 4) พ.ศ. 2552 ลงวันที่ 30 ต.ค. 2552
- ล่าสุดโรงงานที่มีน้ำทิ้งตั้งแต่ 500 Q/วัน ต้องติดตั้งระบบ OPMS



## เครื่องมือและอุปกรณ์ ที่โรงงานต้องจัดเตรียม

- 1) เครื่องวัดซีโอดี/ บีโอดี
- 2) เครื่องวัดปริมาณการไหลของน้ำทิ้ง
- 3) เครื่องวัดปริมาณการใช้ไฟฟ้า
- 4) อุปกรณ์แปลงสัญญาณ
- 5) โปรแกรมลูกข่าย/โปรแกรมเชื่อมต่อ(VPN)
- 6) เครื่องคอมพิวเตอร์
- 7) ระบบเครือข่าย (Internet/Air card)



## การเชื่อมต่อข้อมูลระหว่าง OPMS Server กับโรงงานอุตสาหกรรม

### >> COD / BOD Analyzer



TOC method



UV method



### >> Flow Meter



### >> Watt Meter



### อุปกรณ์แปลงสัญญาณ Analog to Digital



คอมพิวเตอร์โรงงาน/ โปรแกรมลูกค้า/ โปรแกรมเชื่อมต่อ (VPN)

ระบบเครือข่าย  
Internet/ Aircard



ระบบคอมพิวเตอร์  
กรมโรงงานอุตสาหกรรม



\*\*\*Option : Self Monitoring

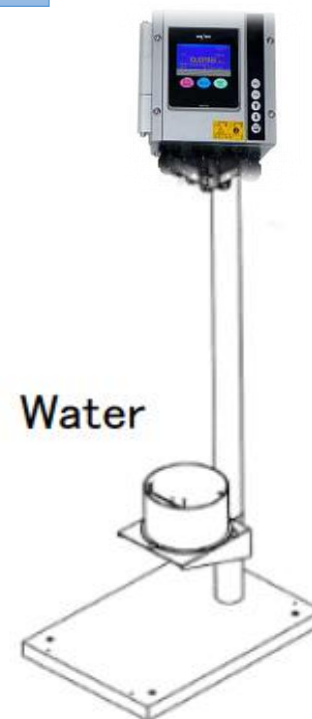
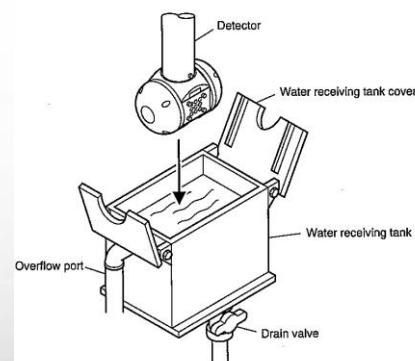
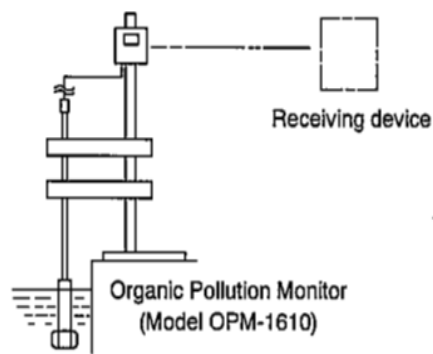
# BOD-COD(UV METHOD) MODEL OPM-1610

Immersion type

Sampling type



Low cost  
Low maintenance  
Low consumable part



# **BOD-COD(UV METHOD)**

## **MODEL OPM-1610**

### **Specification (1)**

- Measuring method : 2 Wavelength absorbance measurement  
(UV light : 254nm\*\*, Visible light : 660nm)
- Wash method : Automatic wash of cell window by wiper  
Operation : 1 wiper cycle at 1 time  
Interval : 1 to 9999 minutes
- Calibration method : Zero calibration : Pure water  
Span calibration : Potassium Hydrogen Phthalate (KHP)

**\*\*UV253.7 (254)nm is 5910B Standard method of The Examination of Water and Wastewater which suitable for COD**

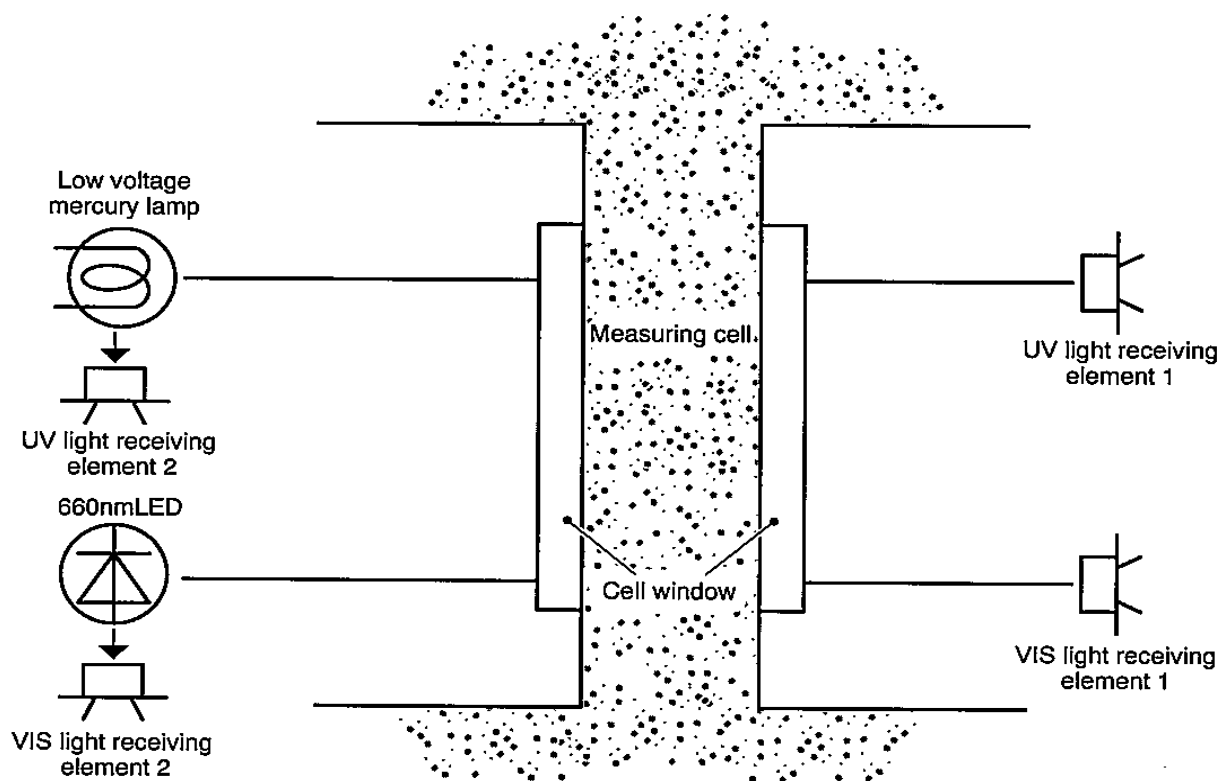


# **BOD-COD(UV METHOD) MODEL OPM-1610**

## **Specification (2)**

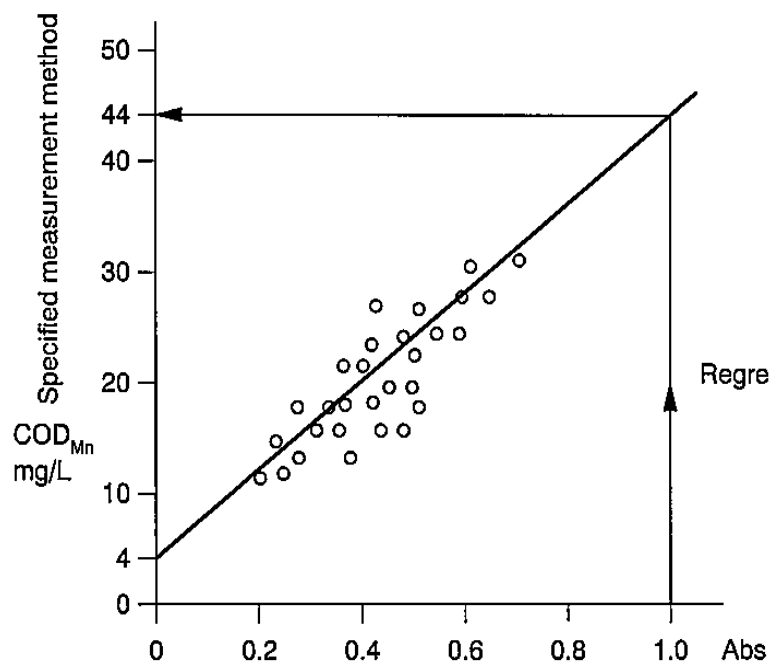
- Power supply : 100 to 240 VAC
- Power consumption : 10 VA (average), approx. 20 VA (max)
- Measuring range COD : 0-2000 mg/L, BOD : 0-200 mg/L
- COD/BOD value is converted with correlation curve  $y = a + bx$
- Display : COD/ BOD/ UV/ VIS
- Output signal : Transmission : 4-20 mA, Contact : 3 contacts  
(lamp failure, no sample, leak sensing)

# BOD-COD(UV METHOD) MODEL OPM-1610





# BOD-COD(UV METHOD) MODEL OPM-1610



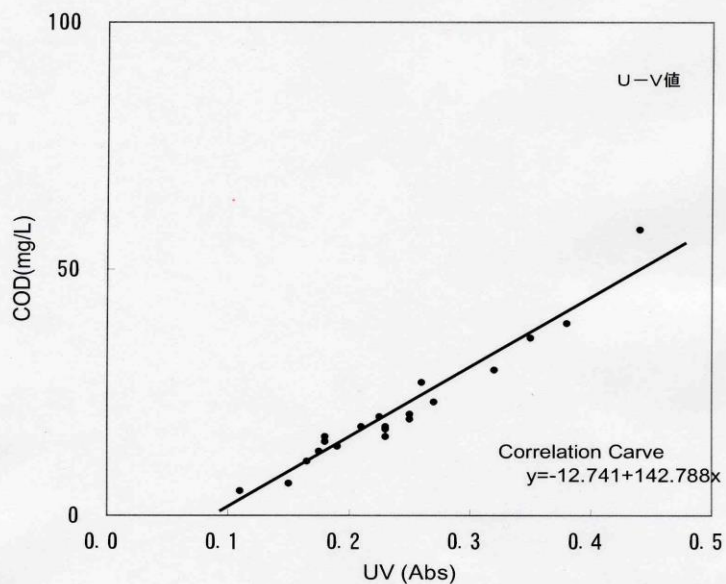
Scatter Chart Example

Regression formula  $y = a + bx$   
 y: COD(BOD) measured values  
 (mg/L) by lab analysis  
 x: Measured value (Abs) by this  
 product  
 a: Intercept  
 b: Regression coefficient (slope)

# BOD-COD(UV METHOD) MODEL OPM-1610

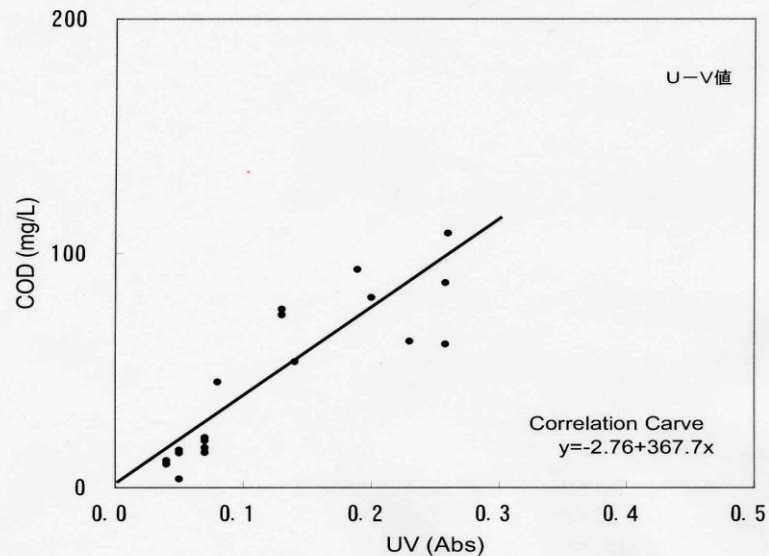
Correlation of COD Automatic Analyzer & UV Analyzer  
(UV Monitor)

Paint Factory



Correlation of COD Automatic Analyzer & UV Analyzer  
(UV Monitor)

Synthetic Dye • Organic Pigment



# BOD-COD(UV METHOD) MODEL OPM-1610

## Measurement Mode Operation (MEAS)

(a) In the “measurement mode” the following values can be checked.

| Absorbance measured value | Each measured value | Others         |
|---------------------------|---------------------|----------------|
| U-V                       | COD                 | Each set value |
| UV                        | SS                  |                |
| VIS                       | Turbidity           |                |
| ---                       | Temperature         |                |

(b) The main display and bottom display are switched by pressing the following keys:

|               | Main display | Bottom display |
|---------------|--------------|----------------|
| Operation key | ↑            | ↓              |

# BOD-COD(UV METHOD) MODEL OPM-1610

## Troubleshooting Error and Corrective actions

Kinds of Errors

| Error indication             | Error name          | Error removing method |                                                                                         |
|------------------------------|---------------------|-----------------------|-----------------------------------------------------------------------------------------|
|                              |                     | Mode                  | Operation                                                                               |
| E-1 :<br>HIGH LIMIT HUMIDITY | Detector leak       | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-2 :<br>SAMPLE ERROR        | No sample water     | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-3 :<br>UV LAMP FAIL        | UV lamp error       | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-4 :<br>VIS LAMP FAIL       | VIS lamp error      | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-5 :<br>MOTOR DOWN          | Motor error         | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-6 :<br>SAMPLE TEMP         | Temperature error   | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-7 :<br>H_U-V               | U-V absorbance high | Measurement           | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |

(To be continued)

# BOD-COD(UV METHOD) MODEL OPM-1610

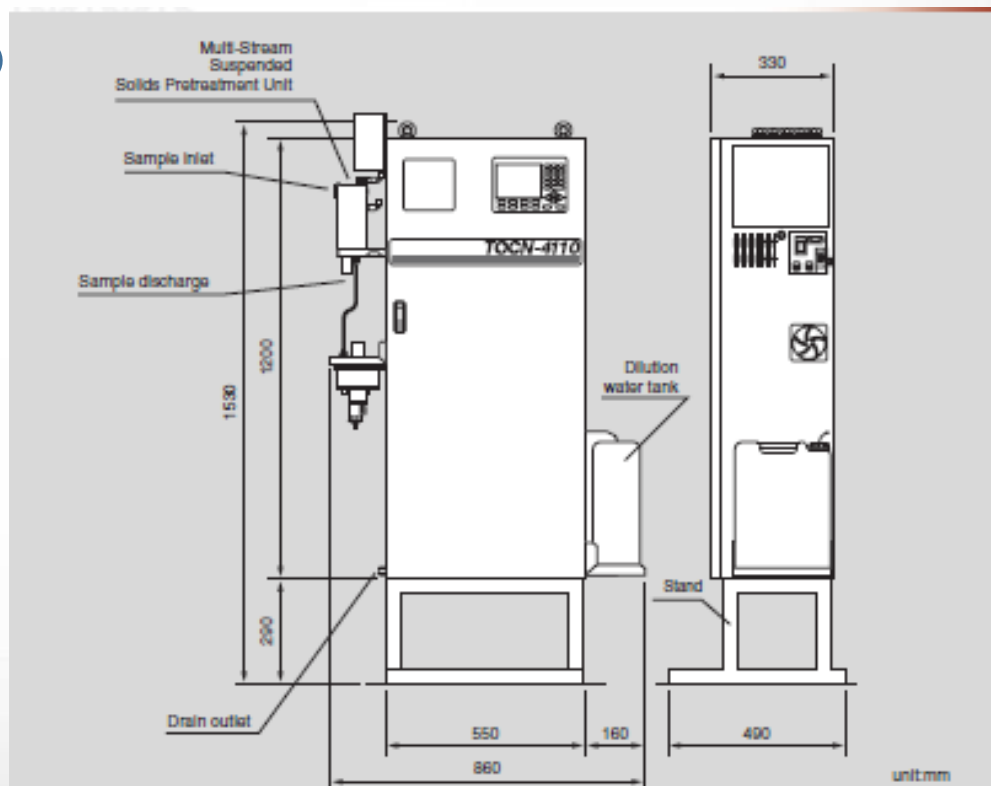
## Troubleshooting Error and Corrective actions

(Continued from previous page)

| Error indication        | Error name                                     | Error removing method       |                                                                                         |
|-------------------------|------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------|
|                         |                                                | Mode                        | Operation                                                                               |
| E-8 :<br>H_UV           | UV absorbance high                             | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-9 :<br>H_VIS          | VIS absorbance high                            | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-10 :<br>H_COD         | COD concentration high                         | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-11 :<br>H_SS          | SS concentration high                          | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-12 :<br>H_TURB        | Turbidity high                                 | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-13 :<br>REAGENT ENPTY | No reagent                                     | Measurement                 | Press <b>(ST-BY/MEAS)</b> for 4 seconds or more.<br>(Select the maintenance mode first) |
| E-14 :<br>ZERO CAL FAIL | Zero calibration error                         | Maintenance/<br>Calibration | Press <b>(ESC)</b> for 1 second or more.                                                |
| E-15 :<br>UV CAL FAIL   | UV span calibration error                      | Maintenance/<br>Calibration | Press <b>(ESC)</b> for 1 second or more.                                                |
| E-16 :<br>TURB CAL FAIL | Turbidity span calibration error               | Maintenance/<br>Calibration | Press <b>(ESC)</b> for 1 second or more.                                                |
| E-17 :<br>OUT OF TEMP   | UV span calibration solution temperature error | Maintenance/<br>Calibration | Press <b>(ESC)</b> for 1 second or more.                                                |

# BOD-COD(TOC METHOD) MODEL TOC-4200

High accuracy for  
All application





# **BOD-COD(TOC METHOD) MODEL TOC-4200**



# BOD-COD(TOC METHOD) MODEL TOC-4200

On-Line TOC Analyzer

## TOC-4200: Features

### Easy to Use

- Simple operation by **color LCD touch screen**.
- Set diverse measurement schedules.  
**Calendar functions** allow precise settings of holidays and operation days.
- **Interrupt measurements** simplify popular offline measurements.
- **Notification when replacement** of consumables is required.

### Support for a Wide Range of Samples (1) → Diverse Applications

- Uses Shimadzu's proven 680 °C combustion catalytic oxidation method.
- Select a sampling unit to match the sample characteristics.
- Supports 5 mgC/L to 20,000 mgC/L full-scale.  
**High sensitivity measurements from 0 to 1mgC/L\***
- Supports many types of TOC measurements (NPOC, TC-IC\*, NPOC + POC\* measurements).
- Automatic dilution function (50× max.) handles acid and alkaline samples.
- **High-salt sample combustion tube kit** handles samples with high levels of inorganic salt, such as seawater samples\*.

# **BOD-COD(TOC METHOD)**

## **MODEL TOC-4200**

- **Final effluent monitoring**

- A substitute for the official analytical method (manual BOD/COD measurement) that permits automated, high-frequency measurements of organic pollutants in effluent.
- Measurements at a short measuring cycle (4 minutes minimum) rapidly capture dramatic changes in organic matter or abnormal effluent.
  - ➔ Provides data for voluntary effluent management and report data agreed to by local government.



- **Total pollutant load control regulation applications (organic pollution load)**

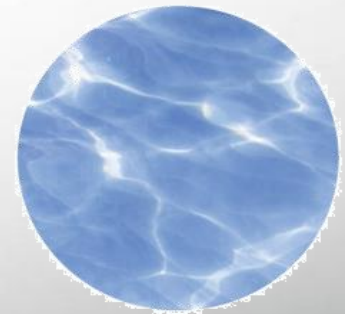
- Converting the measured TOC values into COD values allows applications to COD total volume control.
- TOC  $\Rightarrow$  COD conversion functions are installed as standard.

# **BOD-COD(TOC METHOD) MODEL TOC-4200**

- **Wastewater treatment plant influent (upstream monitoring)**
  - Measurements at a short measuring cycle (4 minutes minimum) rapidly capture fluctuations in organic pollutants in influent. Contributes to load control and prevention of abnormal effluent outflow in treatment systems.
  - A TOC analyzer can detect all organic substances. It captures organic pollutants missed by UV detectors.
  - Permits measurement of up to 6 flow lines for precise monitoring of a treatment facility.
- **Plant water (washing water, cooling water, recovered water, boiler water, condensate, etc.)**
  - Permits continuous monitoring of all process water used in a plant.
  - Measurements at a short measuring cycle (4 minutes minimum) rapidly detect malfunctions and accidents.

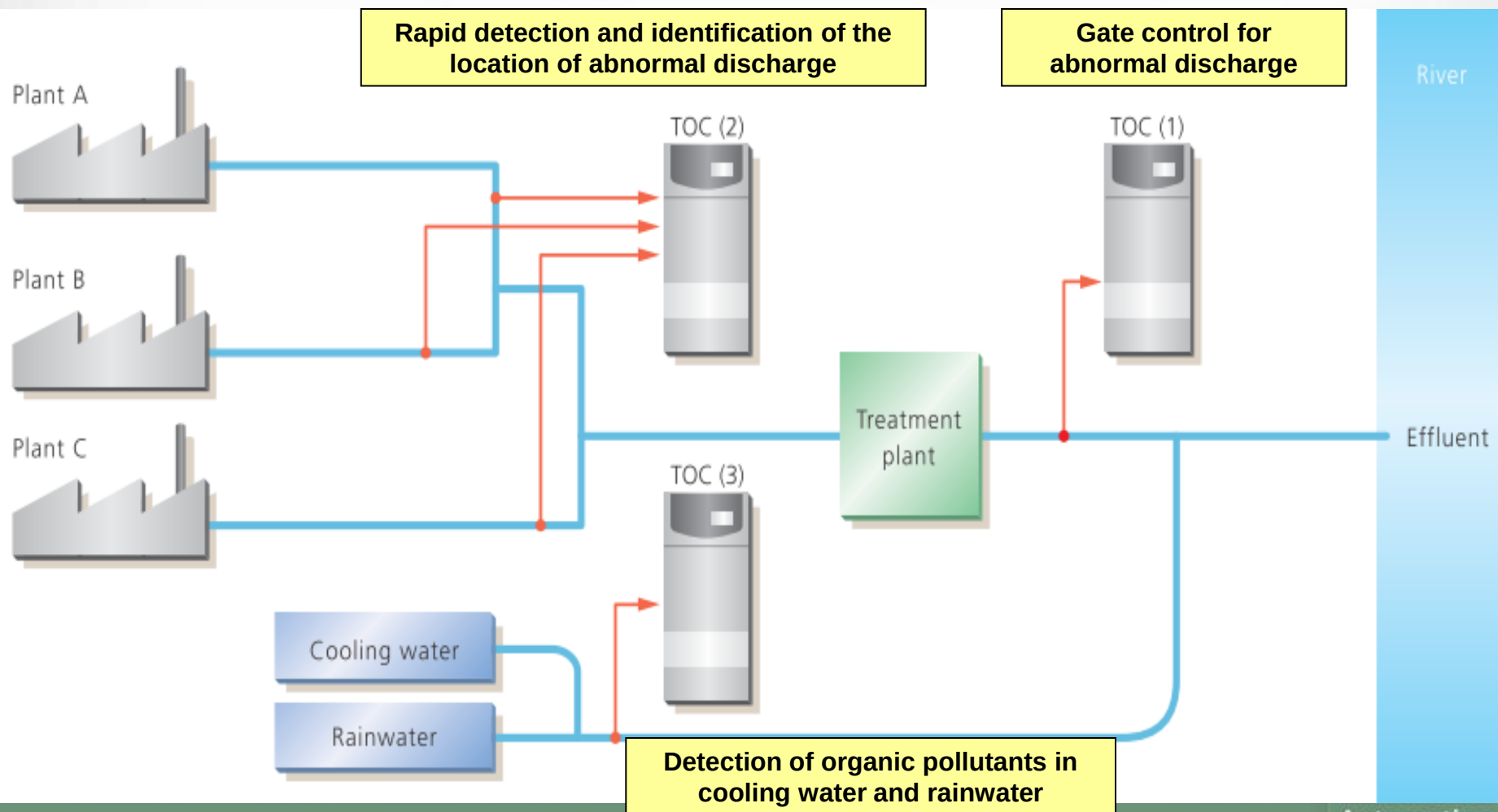
# **BOD-COD(TOC METHOD) MODEL TOC-4200**

- Monitoring of river water sampled at water purification plants and treated water (tap water)
  - Monitoring of fluctuations in sampled water quality due to rain and feedback to treatment processes
  - Monitoring of water quality problems upstream of sample inlet due to effluent discharge accidents
  - Permits simultaneous monitoring of treated tap water.
  - Supports monitoring TOC Removal Rate based on EPA regulations.



## Diverse Applications:

### Example of Upstream Monitoring



## Diverse Applications

Covers a Wide Range from Pure Water to Heavily Polluted Water

- **Uses Shimadzu's proven 680 °C combustion catalytic oxidation method**
  - Detects all organic substances, even in samples with suspended solids.
- **Measuring range from 5 mg C/L to 20,000 mg C/L (50× sample dilution)**
  - An option can be attached to support high sensitivity measurements to 1 mg C/L full-scale.
- **Permits TOC measurements that match a sample's characteristics**
  - TOC measurement by acidify and sparg TOC also know as non-purge able organic carbon (NPOC)
  - TOC determination by difference between total carbon (TC) and inorganic carbon (IC)  
 $TOC = TC - IC$  (requires option)
  - TOC determination by addition method of NPOC and purgable organic carbon (POC)  
 $TOC = NPOC + POC$  (requires option)
- **Simultaneous TN measurements**
  - The TN measurement option permits TN measurements using the catalytic thermal decomposition-chemiluminescence method (measuring ranges: 0–1 mg N/L to 0–10,000 mg N/L).



## Diverse Applications

### Sampling Unit

- **From pure water to heavily polluted water**
  - The sampling unit for heavily polluted water incorporates a unique washing function and special operation sequences to control blockages and biological contamination. This reduces the maintenance frequency.
  - The sampling unit for pure water restricts exposure of the sample to the environment and inhibits contamination of the sample from the environment.
- **Models are available to switch between up to 6 sample flow lines**
  - More economical as the need for multiple instruments is eliminated (reduced instrument and piping costs)
  - Thorough internal and external washing reduces cross-contamination between flow lines

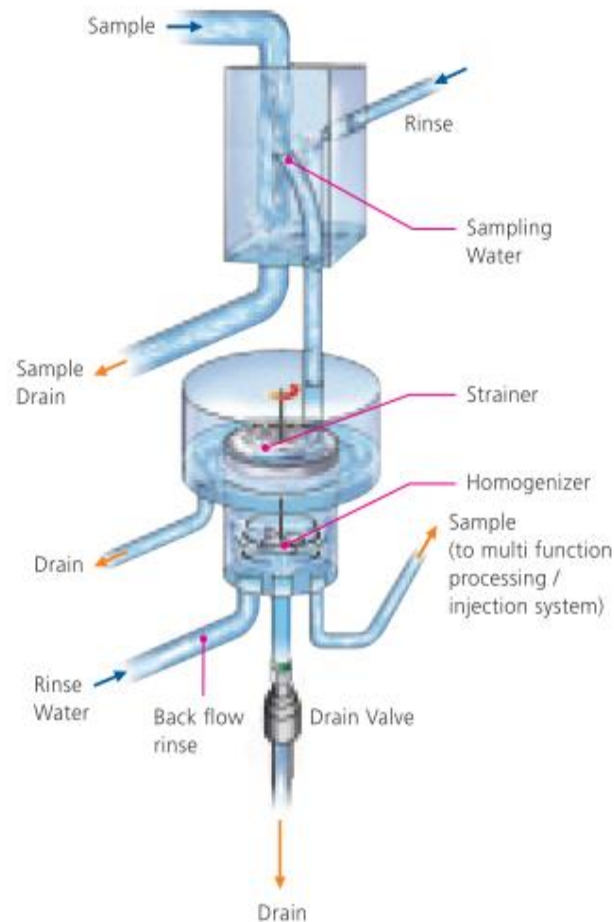


## Diverse Applications

### Sampling Unit: Multi-Stream Suspended Solids Sampling Unit



- Support for samples with high suspended solids levels
  - Incorporates a homogenizer equipped with a strainer.
  - Automatic washing of liquid-contact parts.  
⇒ Prevents blockage due to slime or algae build-up.
  - Separate sampling unit and pretreatment unit  
⇒ Fewer parts requiring maintenance
- Handles up to 6 flow lines
- Required sample flow rate: 10 L/min
- Low-flow model available
  - Required sample flow rate: 1 to 2 L/min

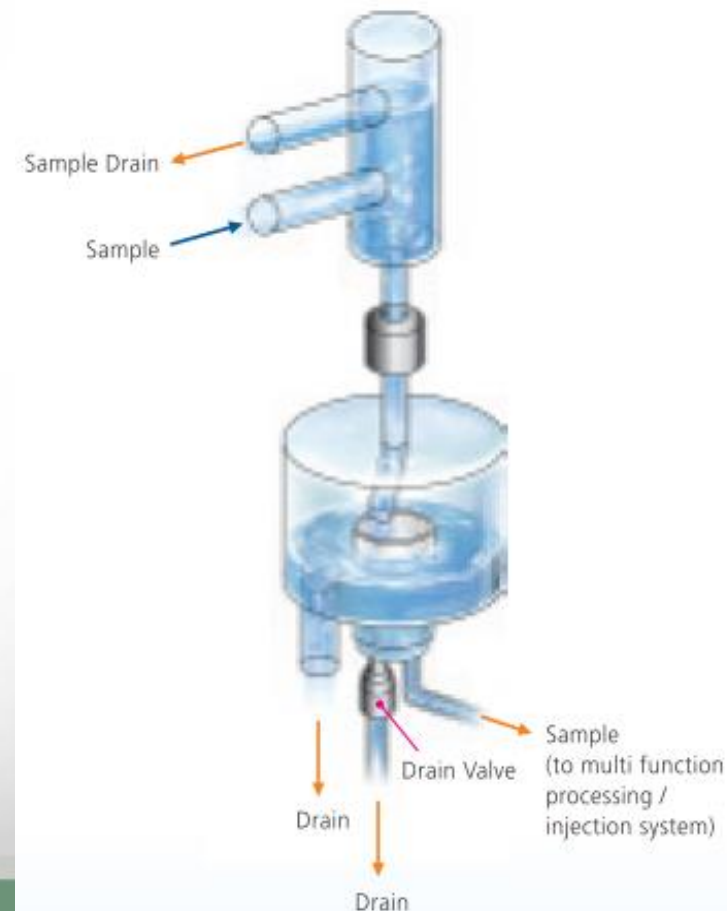


## Diverse Applications

### Sampling Unit: Multi-Stream Sample Switching Unit



- Support for samples with low suspended solids levels
  - Assuming measurements of purified water, a water sampler is installed to minimize exposure of the sample to air.
- Handles up to 6 flow lines
- Required sample flow rate: 1 to 3 L/min



## Diverse Applications

### Automatic Dilution Function, High-Salt Sample Combustion Tube Kit

- **Automatic dilution function**

- TOC-4200 offers automatic dilution functions ( $\times 2$  to  $\times 50\times$ ) as standard.
- Dilution functions do more than extend the measurement range...
  - When measuring an acid, strong alkaline, or inorganic salt sample that may damage the instrument or consumables, the effect can be alleviated by diluting the sample.
  - TOC-4200 permits automatic dilution measurements, regardless of the measurement range.

- **Combustion tube kit for salinity samples**

- When measuring samples with high levels of inorganic salt, such as seawater, the inorganic salt can accumulate inside the combustion tube and cause physical blockage or deterioration of the combustion tube. This kit extends the tube-replacement period approximately ten times as compared to a normal combustion tube.

## Easy to Use

### Color LCD Touch Screen

- Easy operation by color LCD touch screen
  - Intuitive operation
  - Large-button design and pressure-sensitive touch screen permit operation while wearing gloves.
  - The transparent front panel prevents operation when door is closed. Door key and software password offer security.
  - Multi-language support (English, German, Japanese, Chinese)





## Easy to Use

### Diverse Scheduling Functions

- **Simple schedule setup**

- Simply setting the measured item, range, and measurement period for each flow line makes it easy to enter even complex measurement schedules.

Online Meas.>Cond.>Schedule 2/3

|   | Stream | Cycle(Min) | Repetition |
|---|--------|------------|------------|
| 1 | S#1    | 30         | 3          |
| 2 | S#2    | 15         | 1          |
| 3 | S#3    | 60         | 2          |

Cancel Clear Prev Next

Ready 18:11

- **Calendar**

- The calendar simplifies scheduling for automatic calibration, instrument sleep function, control sample measurement, and catalyst regeneration (up to 14 weeks).
- Batch inputs can be made by specifying a day of the week.

Online Meas.>Cond.>Schedule 3/3

| Sun    | Mon | Tue | Wed    | Thu | Fri   | Sat    |     |
|--------|-----|-----|--------|-----|-------|--------|-----|
| Fau    |     |     | Res    |     |       | Cal    | Adv |
| 21     | 22  | 23  | 24 Res | 25  | 26    | 27 Cal | Aug |
| 28 Fau | 29  | 30  | 31 Res | 1   | 2 Fau | 3 Cal  | Sep |
| 4 Fau  | 5   | 6   | 7 Res  | 8   | 9     | 10 Cal |     |

Cal:Cal. Res:Cat. Reg. Ctrl:Ctrl Smpl Fau:Pause

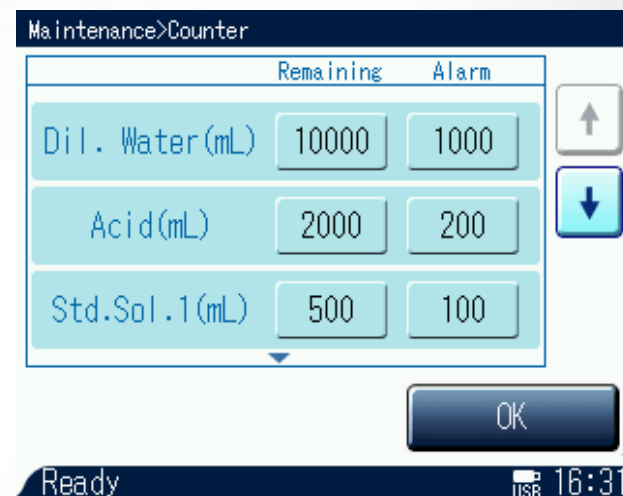
Cancel Previous Week Next Week Prev OK

Ready 18:16

## Easy to Use

### Management and Notification of Replacement Periods for Consumables

- **Management of replacement periods for consumables**
  - Management functions for replacement periods of consumables (reagents, etc.)
  - Recommended replacement periods of consumables are evaluated from the operation status.
  - By inputting the actual volumes, reagents can be managed according to the prepared reagent volumes.
- **Notification of replacement periods**
  - When the time to replace a consumable approaches, a pop-up window notifies the operator and gives instructions.
  - Combining the contact outputs and other warning outputs simplifies consumables management.





## Low Maintenance, Low Running Costs

### Carrier Gas Purification and Saving Functions

- **Carrier gas purification function as standard**

- Carrier gas purification function is installed as standard for 24-hour continuous operation by the online TOC analyzer. Purifying instrument or compressor air in a facility to produce carrier gas significantly reduces running costs.

- **N<sub>2</sub> carrier gas kit**

- Compressed air is normally used as the carrier gas source but high-purity nitrogen gas can also be used as the carrier gas. Convenient when a nitrogen gas centralized pipe is available in a facility (optional).

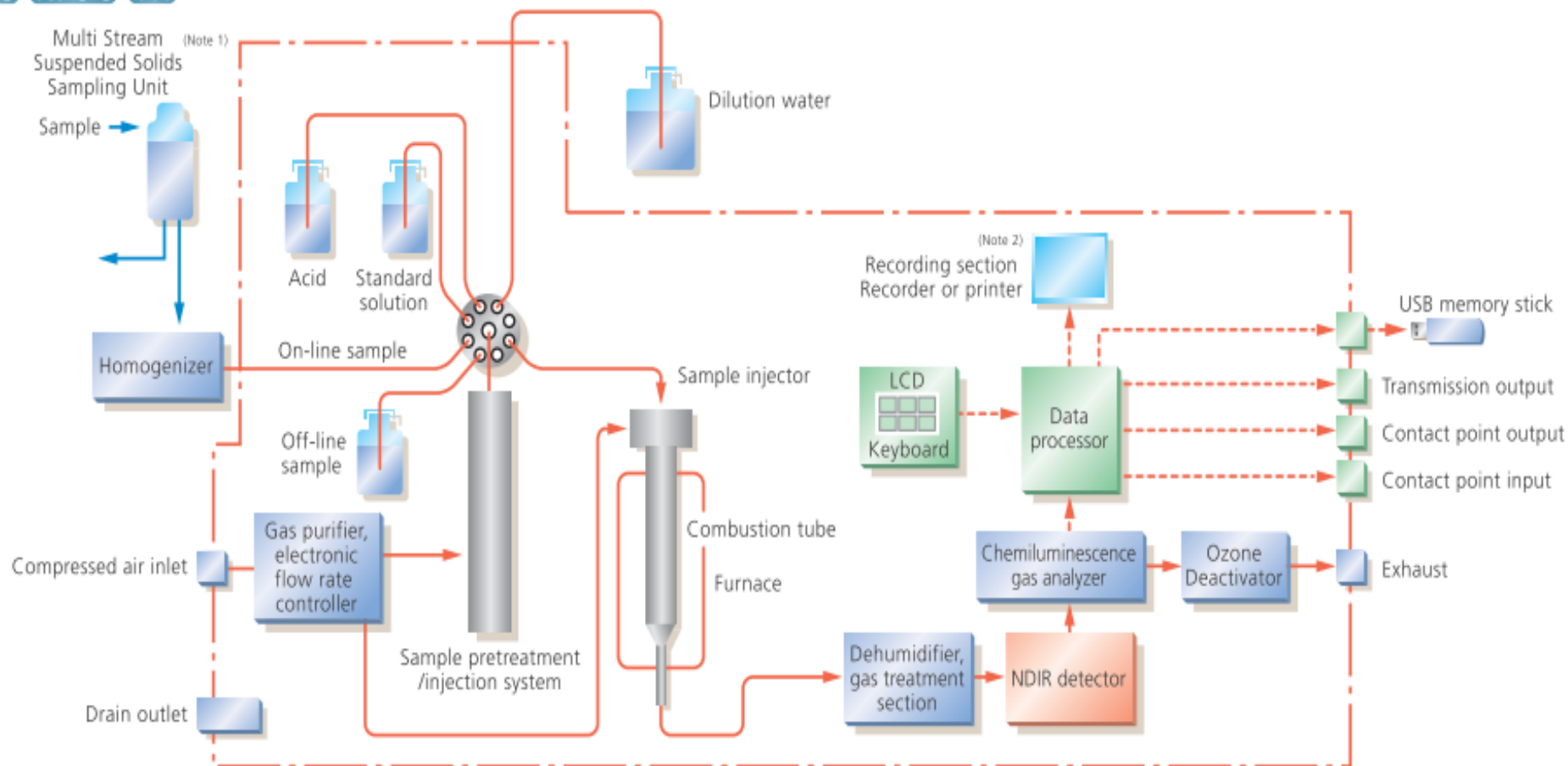
- **Gas cylinder-adaptation (carrier gas saving function)**

- A gas cylinder (high-purity air) can be used in facilities where no instrument air pipes or compressor are available.
- The carrier gas-saving function is provided because using gas from a cylinder increases the running costs. (Carrier gas can be saved more efficiently as the measurement interval increases.)
  - Using the carrier gas-saving function in combination with the normal carrier gas purification function reduces the frequency of compressor maintenance.

## Low Maintenance, Low Running Costs

### TOC-4200 Flow Diagram

TC NPOC TN



## Comprehensive Conventional Communications Functions

### Contact I/O, Analog I/O

- **Contact output**

- 10 channels standard. Expand to 36 channels.
- Supported events are programmable.

- **Contact input**

- Supports standard single flow line measurements.
- Expansion 1 supports measurements with contact control up to 3 flow lines.
- Expansion 2 supports measurements with contact control up to 6 flow lines.
- Supported events are fixed.

- **Analog output**

- 2 channels standard. Expandable in 2-channel increments to 12 channels max.
- Select 4–20 mA or 0–16 mA output.

- **Analog input**

- Supports 3 flow lines max. (optional).
- Dedicated flow inputs (for load calculations).

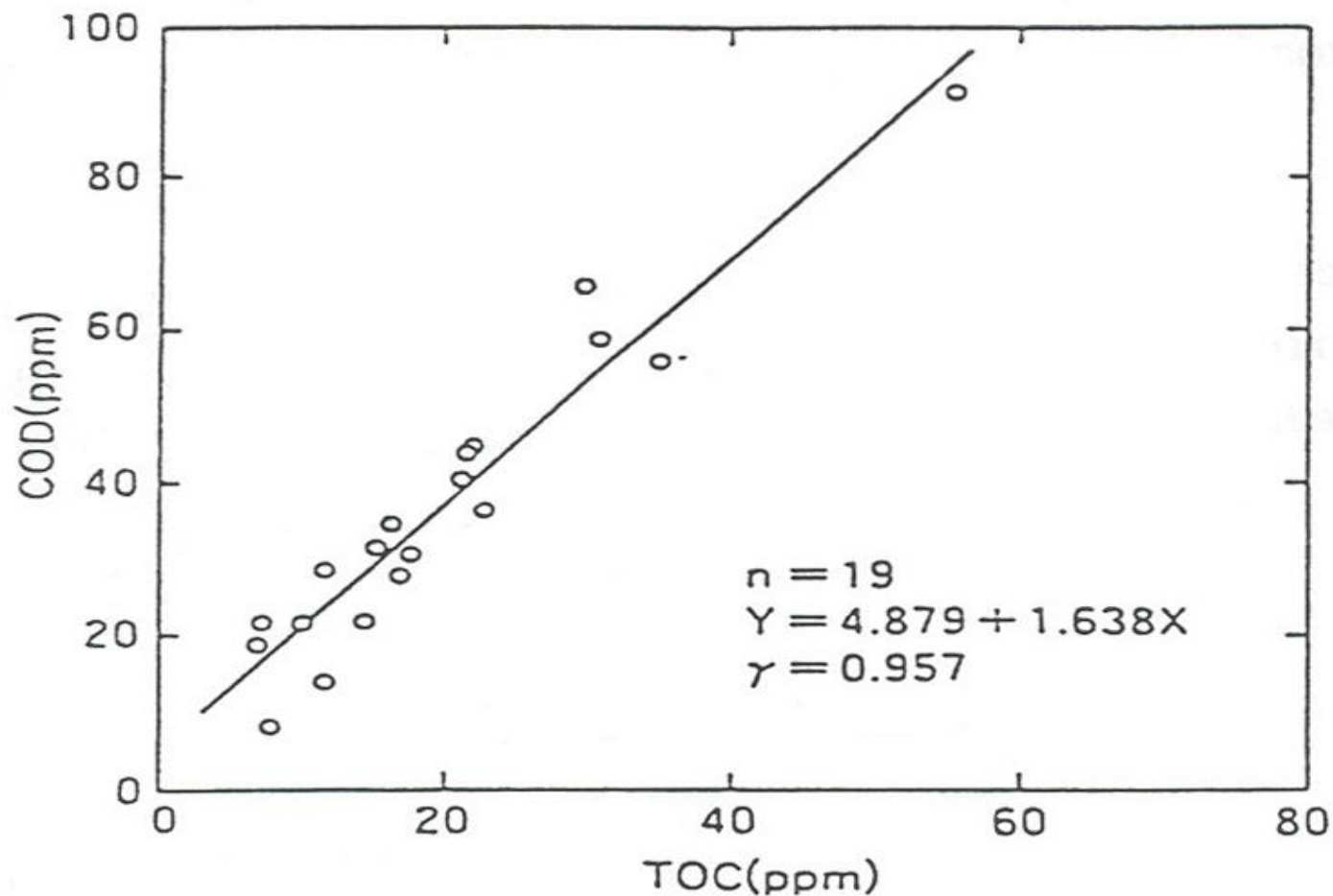


## Enhanced Data Handling

### Powerful Data Storage and USB Memory

- Internal memory can hold:
  - (1) 20,000 measured values  
(approx. one year's data at a 30-minute measuring cycle)
  - (2) History of 100 calibrations (weekly calibration over approx. two years)
  - (3) History of 100 alarms
- Saved data can be output to USB memory
  - Data saved to USB memory in CSV format
  - Use PC spreadsheet software to edit the data or to generate reports.





## Site reference (1)

| Company                                | Parameter    | Method     | Location    |
|----------------------------------------|--------------|------------|-------------|
| AISIN THAI AUTOMOTIVE CASTING CO.,LTD. | COD/BOD      | TOC AND UV | PRACHINBURI |
| BLCF POWER PLANT                       | COD/BOD      | UV         | RAYONG      |
| BLCF POWER PLANT                       | COD/BOD      | TOC        | RAYONG      |
| TENMA PAPER CO.,LTD                    | COD/BOD      | UV         | PATHUMTANI  |
| DOW CHEMICAL                           | COD (3 SETS) | TOC        | RAYONG      |
| THAI POLYCARBONATE CO.,LTD             | COD          | TOC        | RAYONG      |
| TOSTEM THAI CO.,LTD                    | COD (2 SETS) | UV         | PATHUMTANI  |
| บ. ผลิตภัณฑ์พลาสติกไทย จก.             | COD          | UV         | PATHUMTANI  |
| โรงงานอุตสาหกรรมกระดาษบางปะอิน         | COD          | UV         | AYUTTAYA    |
| THAI POLYACETAL CO.,LTD.               | COD (2 SETS) | TOC        | RAYONG      |



## Site reference (2)

| Company                                   | Parameter    | Method | Location     |
|-------------------------------------------|--------------|--------|--------------|
| YAKULT                                    | BOD          | UV     | BANGKOK      |
| YAKULT                                    | BOD          | UV     | AYUTTAYA     |
| PURAC(THAILAND)CO.,LTD                    | COD          | TOC    | RAYONG       |
| THAI TINPLATE CO.,LTD                     | COD          | UV     | SAMUTPRAKARN |
| PHOENIX PULP AND PAPER                    | COD          | UV     | KHONKHAEN    |
| PANASONIC (THAILAND) CO.,LTD              | COD          | UV     | KHONKHAEN    |
| Cho Heng Rice Vermicelli Factory Co.,Ltd. | COD/BOD      | TOC    | NAKHONPATHOM |
| BAYER PREMIER CO.,LTD.                    | COD (6 SETS) | TOC    | RAYONG       |
| DISIN (THAILAND) CO.,LTD                  | COD          | UV     | KHONKHAEN    |
| MC TOWA SWEETENER CO.,LTD.                | COD (2 SETS) | TOC    | RAYONG       |

## Site reference (3)

| Company                         | Parameter     | Method       | Location     |
|---------------------------------|---------------|--------------|--------------|
| NISSAN AUTOMOBILE               | TOC           | COD (2 SETS) | SAMUTPRAKARN |
| NISSAN MOTOR                    | UV            | COD (4 SETS) | SAMUTPRAKARN |
| THAI NOK CO.,LTD                | TOC           | COD          | CHONBURI     |
| PURAC (THAILAND) CO.,LTD        | TOC           | COD (2 SETS) | RAYONG       |
| TOYOTA MOTOR (THAILAND) CO.,LTD | TOC           | COD          | SAMUTPRAKARN |
| TOYOTA MOTOR (THAILAND) CO.,LTD | UV            | COD/ BOD     | BANPHO       |
| TOYOTA MOTOR (THAILAND) CO.,LTD | TOC           | COD          | BANPHO       |
| TOYOTA MOTOR (THAILAND) CO.,LTD | TOC           | COD (3 SETS) | GATEWAY      |
| SINGHA BEER                     | UV            | COD          | NAKHONPATHOM |
| SINGHA BEER                     | TOC (PROCESS) | COD          | NAKHONPATHOM |

## Site reference (4)

| Company                          | Parameter    | Method | Location          |
|----------------------------------|--------------|--------|-------------------|
| DENSO (THAILAND) CO.,LTD.        | COD          | TOC    | CHONBURI          |
| THAI TORAY SYNTHETICS CO.,LTD.   | COD (2 SETS) | TOC    | BANGKOK           |
| POSCO THAINOX STAINLESS CO.,LTD. | COD (2 SETS) | TOC    | RAYONG            |
| THAI HONDA (LADKABANG)           | COD          | UV     | BANGKOK           |
| ISUZU MOTORS (THAILAND) CO.,LTD. | COD          | TOC    | SAMUTPRAKARN      |
| THAI MMA CO.,LTD.                | COD          | TOC    | RAYONG            |
| PROSPER FOODS CO.,LTD.           | BOD          | UV     | PRACHUABKHIRIKHAN |
| MANDARIN SPINNING CO.,LTD.       | COD          | UV     | NONTABURI         |
| THAI TAFFITA CO.,LTD             | COD          | UV     | RAYONG            |
| TUNTEX TEXTILE CO.,LTD.          | COD          | TOC    | RAYONG            |
| HOYA LENS                        | COD          | UV     | LAOS              |

## Site reference (5)

| Company                         | Parameter    | Method | Location    |
|---------------------------------|--------------|--------|-------------|
| SIAM MITSUI PTA CO.,LTD.        | COD (2 SETS) | TOC    | RAYONG      |
| THAI PAPER MILL CO.,LTD.        | COD/ BOD     | UV     | RAYONG      |
| THAI FOOD CO.,LTD.              | COD/ BOD     | UV     | SUPHANBURI  |
| PTT CHEMICAL CO.,LTD.           | COD          | TOC    | RAYONG      |
| JFE STEEL GAVANITE CO.,LTD.     | COD          | UV     | RAYONG      |
| THAI RAYON PUBLIC CO.,LTD.      | COD          | UV     | ANG THONG   |
| YAN WAL YUN CO.,LTD.            | COD          | TOC    | SAMUTSAKORN |
| PTT (R&D) - WANGNOI             | COD/ BOD     | TOC    | AYUTTHAYA   |
| ASIA SILICONES MONOMER CO.,LTD. | COD (2 SETS) | TOC    | RAYONG      |
| NIPPON STEEL GAVANIZE CO.,LTD.  | COD          | UV     | RAYONG      |

## Site reference (6)

| Company                         | Parameter    | Method | Location    |
|---------------------------------|--------------|--------|-------------|
| SIAM MITSUI PTA CO.,LTD.        | COD (2 SETS) | TOC    | RAYONG      |
| THAI PAPER MILL CO.,LTD.        | COD/ BOD     | UV     | RAYONG      |
| THAI FOOD CO.,LTD.              | COD/ BOD     | UV     | SUPHANBURI  |
| PTT CHEMICAL CO.,LTD.           | COD          | TOC    | RAYONG      |
| JFE STEEL GAVANITE CO.,LTD.     | COD          | UV     | RAYONG      |
| THAI RAYON PUBLIC CO.,LTD.      | COD          | UV     | ANG THONG   |
| YAN WAL YUN CO.,LTD.            | COD          | TOC    | SAMUTSAKORN |
| PTT (R&D) - WANGNOI             | COD/ BOD     | TOC    | AYUTTHAYA   |
| ASIA SILICONES MONOMER CO.,LTD. | COD (2 SETS) | TOC    | RAYONG      |
| NIPPON STEEL GAVANIZE CO.,LTD.  | COD          | UV     | RAYONG      |

## Service Team

