INTERPLANT STANDARD - STEEL INDUSTRY		
IPSS	**MEASUREMENT OF MOISTURE CONTENT** *(Second Revision)*	**IPSS: 2-07-077-13** **(Second Revision)**
	No Corresponding IS	Formerly: IPSS:2-07-077-93

0. FOREWORD

0.1 This Interplant Standard (first revision) was prepared by the Standards Committee on Computerization & Automation, IPSS 2:7, with the active participation of the representatives of all the steel plants, other concerned organizations and established manufacturers in the field. Originally, the standard was published in 1993. Based on recent developments, it is revised and adopted in February, 2013.

0.2 Interplant standards on design parameters primarily aim at achieving rationalization and unification of parts and assemblies of process and auxiliary equipment used in steel plants and these are intended to provide guidance to the steel plant engineers, consultants and manufacturers in their design activities.

0.3 This standard was first published in 1988. The first revision has been carried out to update the standard in general.

0.4 The measurement of Moisture has to be of high degree of precision, accuracy and resolution. The associated equipments have to give long term reliable service in normal steel plant atmosphere.

0.5 Moisture data of various substances like air blast in blast furnaces, or coke in coke ovens or blast furnaces become necessary for important process control application.

1. SCOPE

1.1 This Interplant standard specifies the instruments for measurements of moisture in both gaseous and solid substances.

2. TYPES

2.1 The types of the equipment shall be suitable for the following areas:

2.2 **Off-line Measurements** – Extracting and preparing representative samples and carrying out off-line analysis in laboratory.

2.2.1 **Thermal Drying** – It is recognized as the standard procedure for checking all other methods. It can be applied to almost all substances. Procedure is to weigh a sample before and after drying and note the change of weight by loss of moisture for the weighed amount of sample.

2.2.2 For speed of drying, the maximum surface of the sample should be exposed. This requires grinding of the sample. High-moisture content samples are more efficiently handled by pre-drying in either a water oven or by air drying using a heater and fan. Final drying or drying of low-moisture content samples, may be carried out in either natural convection or forced-air or vacuum oven.

a) **Pre-drying Furnace**:

i)	Temperature	:	200^{o}C (temperature controlled)
ii)	Wattage	:	3 kW
iii)	Internal Volume	:	0.5 m x 0.75 m x 0.75 m
iv)	Temperature adjustable in steps, power supply	:	230 V, 50 Hz

b) **Final-drying Furnace**:

i) Vacuum – Rotary pump vacuum of 10 cm Hg approximate

Or

ii) Forced air with blower – Blowing rate 2 lit/ minute at atmospheric pressure

iii) Final drying temperature - 100^{o}C (temperature controlled)

2.2.3 **Environment for drying** – Drying operation is to take place in inert gas atmosphere composed of nitrogen or argon. Inert gas is blown into the furnace at a pressure of 2 atmosphere.

2.3 **On-line Measurement** – On-line measurement is applied for hoppers carrying solid materials, conveyor belts carrying solid materials and pipes or chambers carrying gases, etc.

2.3.1 Nucleonic instrument for hopper based measurement (on-line use).

2.3.1.1 **Design feature** – Neutron moisture gauge consists basically of a measuring head mounted on a hopper containing coke while control unit is placed in a control room. The measuring head contains a radio-isotope source of fast

neutrons, a slow neutron detector and a radiation shield. Fast neutrons emitted from the source successively undergo the processes of slowing down, mainly by collisions with atoms of hydrogen in the moisture of materials situated near the measuring head. The count rate in the slow neutron detector increases with increasing hydrogen content and when most of the hydrogen in the material is in the form of water, the count rate can be used as an indication of moisture content. Source used in the radio-isotope of fast neutrons is AM 241/Be. The detector is He-proportional sealed counter.

2.3.1.2 There should be 2 numbers of detectors on the two sides of the source. The head unit should contain mainly one source unit, 2 numbers of detectors, 2 numbers of pre-amplifiers, reversing mechanism for the source, safety interlock, radiation protection lining, hopper window and pulse driver. There should be provision of compressed air blowing on the surface of the window to keep it clean off coke dust. The head unit packaging should be dust proof and water proof.

2.3.1.3 **Instrument specification**

i)	Weight of the head unit	:	Not more than 200 kg
ii)	Dimension of the head unit	:	0.5 m x 0.5 m x 0.75 m apprx
iii)	Measuring range	:	0-20 percent moisture
iv)	Accuracy	:	1 percent of moisture value
v)	Sampling time	:	30 seconds
vi)	Sample volume measured	:	Hemisphere of 0.8 m radius, minimum
vii)	Operating temperature	:	Head unit to + 70^{o}C Electronics console 0 - 35^{o}C
viii)	Source	:	Am 241/Be
ix)	Source strength	:	300 micu
x)	Pulse height from the head unit	:	5 volts
xi)	Calibration	:	Microprocessor based system. Provision for calibration plates should be there.

xii)	Display	:	a) Count rate : 7 digits b) Moisture content : 4 digits c) Provision for hand held digital display to be hooked up at the site of heat unit
xiii)	Noise content in head unit output	:	Less than 10 db
xiv)	Maximum allowable distance between head unit and main console in control unit	:	500 m
xv)	Compensation	:	Bulk density correction for coke moisture to be provided

2.3.1.4 Self diagnostic features controlled by software shall be provided.

2.3.1.5 Output of 4-20 mA (isolated) shall be provided.

2.3.1.6 The housing shall conform to the norm specified by BARC.

2.3.1.7 The packaging and transportation shall follow the norms laid downed by BARC in their circular No. DRP/Adv/Nlg/P-1/8, June 1984.

2.3.2 Microwave instrument for moisture measurement in solids on conveyor belt shall be provided.

2.3.2.1 Design features – This type of instrument will be used to measure on-line moisture content of materials carried by conveyor belts. The head unit will be installed at site and electronic console will be installed in the control room. The head unit will contain input and output horn, co-axial cable connector. The output horn is meant for radiation of beam on to the surface of material and input horn receives the beam after back scattering from the surface of the material.

2.3.2.2 The incident radiation is constituted of 2 separate carrier frequencies, such that one frequency falls in the absorption band of moisture (8.9 to 10.68 GHz) while the other is well outside the band (less than 2 GHz). These carrier frequencies are pulse modulated and fed to the output horn. The input horn receives back the energy with too much reduction in the amplitude of one frequency and the other frequency with virtually no effect. The waves are processed to compare the amplitudes of two frequencies to give the measurement of water content in the material.

2.3.2.3 The console unit consists of Microwave oscillator, filters, attenuator, amplifier, detector, power supply, and recorder. The housing of the console unit should be a dust-proof, water-proof enclosure.

2.3.2.4 **Specification of the instrument:**

a) Horn:

i)	Length measured along the axis	:	500 mm approximate
ii)	Flare angle	:	Not more than 25^{o}
iii)	Type of Horn	:	Sectoral, flared in H-plane compared to that in E-plane
iv)	Wall thickness	:	Approximately 0.8 mm
v)	Connector	:	Suitable connecting mecha-nism with the co-axial line with adjustable slot for impedance matching

b) Attenuation : Less than 0.01 db per feet

c) Microwave oscillator:

i)	Type	:	The reflex klystron oscillator
ii)	Power	:	500 mw approximate
iii)	Frequency adjustment	:	By tuning plunger
iv)	Overall noise figure should be Kept below 10 db		
v)	Automatic frequency control	:	Automatic frequency control System should be used to correct for slow drifts in the frequencies of transmitter and receiver oscillators
vi)	Accuracy of the system	:	1 percent of the overall mois--ture content
vii)	Moisture range	:	0-25 percent moisture
viii)	Digital display	:	4 digit
ix)	Power Supply	:	230V / 50Hz A. C.

2.3.2.5 Output of 4-20 mA (isolated) shall be provided.

2.3.3 Vapour pressure instrument (dew cell) for pipeline or gas chamber based measurement (on-line use).

2.3.3.1 **Design feature** – This type of instrument will be used for measuring moisture content in gaseous substances. The system operates by automatically maintaining a saturated solution of hygroscopic salt at a temperature which is in equilibrium with the vapour pressure of the measured atmosphere. This equilibrium temperature is sensed by a resistance temperature detector (RTD), and can be expressed directly in any absolute moisture unit by means of a characteristic scale, dial or chart, or a computer analysis. The performance of the dew cell element should be both accurate and stable and should be unaffected by ambient temperature changes.

2.3.3.2 Following characteristics should be maintained:

i)	Dew cell element accuracy	:	$\pm$ 0.8^{o}C at 32 ^{o}C
ii)	Dew point temperature range limits	:	- 45 ^{o}C to + 60 ^{o}C
iii)	Ambient temperature range limits.	:	45 ^{o}C to 60 ^{o}C
iv)	Relative humidity limits	:	12 to 100 percent RH
v)	Pressure rating	:	8.5 bar to vacuum
vi)	Element shield	:	Perforated tube type for gas Velocities up to 0.3 m/s
vii)	Ancillaries for the instruments	:	Weather hood, draft shield, Air cooled sampling chamber, sampling pump, ballast resistor, perforated tube element shield, extension cable as required
viii)	Accuracy of measurement	:	$\pm$ 0.5 percent
ix)	Stability of dew cell element	:	The dew cell element should Require no adjustment or calibration to ensure specified performance within a period of 3 years.

x)	Dew cell assembly with Temperature sensor	:	Though dew cell will function in conjunction with temperature sensor, these should form two physically separate units. Temperature sensor can be easily replaced without disturbing the dew cell. The entire assembly should be complete with sampling chamber.
xi)	Sampling chamber dimension	:	254 mm x 114 mm x 114 mm
xii)	Coupling dew cell with Sampling chamber	:	By brass flange
xiii)	Connection head	:	Cast aluminium body and cover with a rubber gasket. The connection head assembly is weatherproof and dust-tight as defined in IECIP 65 and provides the enrivonmental protection of NEMA type 4.
xiv)	Temperature sensor sheath	:	AISI type 316 stainless steel (316 SS) coated with here-site for electrical insulation
xv)	Heater wires	:	18 or 24 carat gold
xvi)	Element shield	:	Nickel-plated brass tube with perforations
xvii)	Power requirement	:	230 V, 50 Hz AC unregulated ($\pm$ 15 percent)
xviii)	Balast resistor	:	100 w lamp, 30 V
xix)	Sampling pump	:	Diaphragm-type pump (if necessary)
xx)	Draft shield	:	A sheet of steel with perfo-rations should be used at the entry of sample chamber if wind speed exceeds 5 m/s

xxi)	Velocity	:	Rotameters (IPSS:2-07-047-89)
xxii)	Provision for temperature measurement in sampling chamber	:	To be provided